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# CANADIAN DEFENCE PRODUCTS

*Department of*  
DEFENCE PRODUCTION  
CANADA • 1967

(Second Edition—Abridged)





CANADIAN  
DEFENCE  
PRODUCTS  
(ABRIDGED)

SECOND EDITION – MARCH, 1967  
(ABRIDGED)

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(SECOND EDITION — ABRIDGED)

DEPARTMENT OF DEFENCE PRODUCTION  
OTTAWA • 1967 • CANADA



## INTRODUCTION

This publication is an extract of the "Illustrated Section" of the Canadian Department of Defence Production publication, "Canadian Defence Products", to which the reader is referred for a detailed study of Canada's defence related industry.

The illustrated articles on the following pages are examples of some types of equipment conceived and produced in Canada. These equipments should also serve to prove that Canada possesses the engineering and laboratory back-up facilities so vital to a modern and progressive industrial complex. The equipment exhibited is only indicative of the defence related segment of Canadian industry and serves to demonstrate that Canada possesses the inventive resourcefulness and the production skills to meet your requirements.

Inquiries originating in the under-mentioned countries relating to Canadian defence equipment and facilities may be addressed to:

Attache (DDP),  
Department of Defence Production,  
Ambassade du Canada,  
35 Ave. Montaigne,  
PARIS 8e, France.

Attache (DDP),  
c/o Canadian Embassy,  
Via G. B. de Rossi 27,  
ROME, Italy.

Attache (DDP),  
Department of Defence Production,  
c/o Canadian Embassy,  
Zitelmannstrasse 22,  
BONN, Germany.

Director,  
Canadian Department of Defence Production,  
Office of the High Commissioner for Canada,  
Macdonald House,  
No. 1 Grosvenor Square,  
LONDON W.I., England.

Inquiries from other countries should be addressed to the Canadian Embassy in the country concerned and to the attention of the Commercial Section, or, as noted in the remarks on the Canadian Commercial Corporation below.

## CANADIAN COMMERCIAL CORPORATION

Procurement of defence supplies and services for the Canadian Armed Forces is carried out in Canada by the Department of Defence Production. This Department is prepared to procure for other governments any defence requirements they may have in Canada. For this purpose, Canadian Commercial Corporation, which is wholly owned by the Government of Canada and is responsible to the Minister of Defence Production, was established to act as the contracting agency when other countries wish to purchase defence or other supplies and services from Canada on a government-to-government basis. The management and staff of the Corporation are provided by the Department of Defence Production. The result is that defence procurement in Canada, undertaken by the Corporation for other governments, is carried out by the same officers and according to the same standards as procurement being undertaken for the Canadian Armed Forces.

Canadian Commercial Corporation upon receipt of a request for bid or other such enquiry document will, whenever possible, obtain quotations from Canadian contractors or suppliers; evaluate these quotations in accordance with the procurement standards of the Government of Canada; and, where a bid meets these requirements, will submit such bids to the enquiring government. If such bid is accepted, the Corporation will, on behalf of the Government of Canada, enter into a contract with the procuring government and place an appropriately parallel contract with

the Canadian supplier in such manner as to make available to the procuring government the complete defence purchasing organization and procedure used by the Government of Canada.

Some of the advantages to other governments in procuring defence supplies through Canadian Commercial Corporation, in the manner mentioned above, are as follows:

- The Canadian supplier will be chosen where possible on a competitive basis and in any event in accordance with the procurement policies and procedures of the Department of Defence Production.
- The price paid by the procuring government will not be higher than that which would be paid by the Government of Canada were it purchasing for its own use in comparable circumstances.
- The contract with the Canadian supplier will be subject to technical and management control during production by an experienced procurement staff, who will also facilitate any change action which may be required by the procuring government during the performance of the contract and will expedite delivery of the supplies.
- Quality control, inspection and acceptance on behalf of other governments may be carried out in Canada by the Inspection Services of the Canadian Department of National Defence to the extent desired by the procuring government.
- All billings of the Canadian supplier for work performed will be certified by Canadian Commercial Corporation according to Canadian government practices before payment and the Corporation will pay the Canadian supplier on the basis of the agreed payment terms in the contract between the Corporation and the procuring government.
- If an audit of the Canadian supplier's account is required, such audit will be conducted by the Audit Services Branch of the Office of the Comptroller of the Treasury, Department of Finance, Canada.
- Arrangements for shipment of goods will be made by the Corporation as required.
- All contracts entered into by the Corporation are guaranteed by Government of Canada.

Specific enquiries as to price and availability as well as requests for general information on Canadian defence products may, accordingly, be directed to:

Canadian Commercial Corporation,  
Requirements Division,  
MacDonald Bldg.,  
123 Slater Street,  
Ottawa, Ontario.

While the services of Canadian Commercial Corporation, as outlined above, are available without charge to any foreign government in the procurement in Canada of defence or other supplies and services, it is to be noted that this availability of the services of the Corporation in no way precludes foreign governments from procuring in Canada directly from Canadian manufacturers if they so wish. In such circumstances, the Corporation will provide advice and assistance as requested.

# ILLUSTRATIONS

	PAGE
1. The Twin Otter	I-2
2. The Buffalo	I-4
3. The Turbo-Beaver	I-6
4. Canadair CL-84	I-8
5. Canadair CL-89: (AN/USD-501)	I-8
6. Canadair CL-41A Tutor	I-10
7. Canadair CL-41G Tactical Trainer	I-10
8. The DHC-4 Caribou	I-12
9. Amphibious Utility Transport CL-215	I-14
10. Gyroplane (V/Stol Avian 2/180)	I-16
11. The PT6/ST6 500-800 SHP Turbine Engine	I-18
12. Wing Actuator Systems	I-20
13. Main Landing Gear for Tutor Aircraft	I-22
14. Helicopter Landing Gear	I-22
15. Flap Actuator/Control	I-24
16. Two Position Nose Landing Gear: CF-5A	I-24
17. Aircraft Rubber Fuel Cells	I-26
18. Main Landing Gear DHC-5	I-28
19. Mobile Automatic Test Set	I-30
20. "Wortac" — Overall Radar Tester and Calibrator	I-32
21. Aircraft Simulators	I-34
22. Crash Data Recorder	I-36
23. Crash Position Indicator	I-38
24. General Purpose Doppler Sensor	I-40
25. Microminiaturized Doppler Sensors	I-42
26. Supersonic Doppler Sensors	I-44
27. Navigation Computers, Airborne	I-46
28. Automatic Permanent Magnetic Compensator (APMC)	I-48
29. The 9-Term Compensator (9-TC)	I-50
30. Registering "G" Meter	I-52
31. Aerial Reconnaissance Systems	I-54
32. CMA-521 Radar Altimeter	I-56
33. Servo Repeater Amplifier	I-58
34. Servoed Altitude Indicators	I-60
35. Intervalometers	I-60
36. AFDS-2 (Airborne Infra-red Fire Detection System)	I-62
37. Automatic Master Heading Control	I-64
38. Tactical Moving Map Display	I-66
39. Spectocom Head-up Display System	I-68
40. PHI — Position and Homing Indicator	I-70
41. Airborne Inertial Navigation Systems	I-72
42. ISIS "N" System	I-74
43. Weapon Release Computer Set (AN/ASQ-91)	I-76
44. MK5 Airborne Profile Recorder	I-78
45. Stem Devices	I-80



	PAGE
46. Totem .....	I-84
47. Periscope .....	I-86
48. The Black Brant Research Rocket Family .....	I-88
49. Gun Fired Vertical Probes — “HARP” .....	I-90
50. High “G” Electronics .....	I-92
51. High “G” Technology .....	I-94
52. Precision Satellite Tracking Antenna .....	I-96
53. Satellite and Microwave Relay Communications .....	I-98
54. Counter-Mortar Radar AN/MPQ-501 .....	I-100
55. Ionospheric Measurement .....	I-102
56. Low Noise Parametric Amplifiers .....	I-104
57. Dual Keyer, Frequency Shift Exciter .....	I-106
58. Twin-Shift LF Receiver-Decoder .....	I-108
59. Single Sideband Communications Receivers .....	I-110
60. HF Single Sideband Transceiver and Transmitter .....	I-112
61. FM 2-Way Mobile Radio .....	I-114
62. The AN/GRC-103 Radio Relay Equipment .....	I-116
63. Telephone & Telegraph FDM Multiplex Terminal .....	I-118
64. Scientific Satellites & Satellite Subsystems .....	I-120
65. H.F. Sounding System .....	I-122
66. Airborne Digital Computer — AN/UYK-501 .....	I-124
67. Detecting Set, Radar — “Micradet” & AN/ULM-501 .....	I-126
68. Printed Circuits & Edge-Lighted Panels .....	I-128
69. Gas Laser Developments .....	I-130
70. Electronics Signal Processing Research Program .....	I-132
71. Millimeter Reflex Klystrons .....	I-134
72. Precision Deflection Yokes .....	I-136
73. Solid State Power Devices .....	I-138
74. Power Supply PP-5143/PRC .....	I-140
75. Digital to Video Converters .....	I-142
76. Linatrol Tracing System .....	I-144
77. Telepath Communications & Data Control .....	I-146
78. Numerical Control — Machine Tools .....	I-148
79. Aqua-Jet .....	I-150
80. Hydraulic Boat Controls .....	I-152
81. Helicopter Haul Down System .....	I-154
82. Retractable Replenishment Post .....	I-156
83. Precision Depth Sounder .....	I-158
84. Remote Depth Indicator .....	I-160
85. Transistorized Marine Radar — LN 55 .....	I-162
86. Oceanographic Research Winch Systems .....	I-164
87. Bathythermograph Slug .....	I-166
88. Oceanographic Data Collection Instrumentation Vehicle .....	I-168
89. Plastic Gun Shields .....	I-170
90. Forged Steel Valves and Steam Traps .....	I-172

	PAGE
91. Lenses for Air Reconnaissance Cameras .....	I-174
92. Optical-Mechanical Fire Control .....	I-176
93. Pressure Dome Water Contact Lens .....	I-179
94. Training Aids & Simulators .....	I-180
95. Custom Machine Shops .....	I-182
96. Paper Chemical Agent Detector .....	I-185
97. Radiacmeter, Gamma Survey, Low Range, IM-5016/PD .....	I-186
98. Radiacmeter, Gamma Survey, IM-108B/PD .....	I-186
99. Electrostatic Dosimeters .....	I-188
100. Radiacmeter Remote Monitoring Single Probe .....	I-190
101. Radiation Detection System Airborne AN/ADR 501 .....	I-192
102. Detector Radiac Tactical Dosimeter, DT60A/PD .....	I-194
103. Radioactivity Survey Training Set .....	I-196
104. Irradiation Equipment .....	I-198
105. Blood Testing Kit Cholinesterase .....	I-200
106. Detector Chemical Agent (Nerve Vapour) .....	I-203
107. Case, Water Testing, Poisons .....	I-204
108. Support Kit, Overhead Protection, C1. (SKOP) .....	I-206
109. Navigation Set, Land Vehicular C2 .....	I-208
110. Land Navigation System — LNS102 .....	I-210
111. Gyroscopic Compasses .....	I-212
112. Mechanical Ball Resolvers .....	I-214
113. Fluidic Elements .....	I-216
114. Plastics Flogun .....	I-218
115. Impact Extrusion Components .....	I-220
116. Gearing .....	I-220
117. Chain Beam Loader .....	I-222
118. Low Ground-Pressure Tracked Carriers .....	I-224
119. "Dynatrac" — (XM-571) .....	I-226
120. Off-Highway Tracked Carriers .....	I-228
121. Heavy-Duty Construction Vehicles .....	I-230
122. Heavy-Duty Construction Vehicles .....	I-231
123. Light-Weight Reconnaissance Vehicle (Snow) .....	I-232
124. Snow Vehicles .....	I-234
125. Light-Weight Small Arms Ammunition Pack .....	I-236
126. Signal Underwater Sound MK 400 and MK 401 .....	I-238
127. Marker Location Marine MK. 25, MOD. 2 .....	I-238
128. Mine Anti-Personnel Non-Metallic C3/M25 .....	I-240
129. Mine Anti-Personnel Non-Metallic Practice C4 .....	I-240
130. Helicopter Transportable Housing Facilities .....	I-242
131. Transportable Housing Complex .....	I-243
132. Canadian Arsenals Limited .....	I-244

## ILLUSTRATIONS

The illustrated section of this book has been included to give you some insight into some of the equipments now being designed, developed and produced in Canada. The not so obvious use of this section is to be found if a deeper evaluation of each item is made for then you will become aware of the engineering available, the production facilities and laboratory back-up so vital to a modern industrial complex.

It is hoped that this illustrated section will serve to demonstrate that Canada possesses the proven competence in resourceful production skills to meet your requirements.



## THE TWIN OTTER

Over the past twenty years de Havilland Aircraft of Canada have provided to STOL airplane users, in most regions of the world, some of the finest and most advanced craft in this field. Their experience, together with the reliability of their product, has virtually followed a building block technique. The Beaver, working in some 65 countries around the world, was followed by the higher load capacity Otter which also joined Beaver fleets. The twin engine Caribou and her higher capacity sister the Buffalo, which followed, have both found world wide acceptance where STOL aircraft are a requirement.

Now a further refinement on a proven aircraft is offered in the DH6 Twin Otter. The Twin Otter, while offering a greatly increased payload, still provides the unique combination of short-field ability, ease of handling and simple, low cost maintenance which the spectrum of applications encompasses for both commercial and military transport roles.

Powered by two PT6A-20 gas turbine engines, the Twin Otter seats 20 for high density, short-haul air commuter applications. As an air ambulance it will accommodate nine stretchers and three attendants. It will carry 4430 lbs. (2010 kg) for a range of 100 miles (161 km) as a cargo transport.

Short-field performance is an impressive Twin Otter feature, without structural or mechanical complexity. At full gross weight of 11,579 lbs. (5252 kg) sea level, standard day, zero wind, the take-off distance to clear a 50 ft (15 m) obstacle is 1240 ft (378 m) and for landing 950 ft (290 m) same conditions.

The cabin is constructed for maximum space utilization, the floor designed for static loads of 200 lb./sq. ft. (91 kg/929 cm<sup>2</sup>), with the luggage compartment floor for 100 lb./sq. ft. (45.4 kg/929 cm<sup>2</sup>). A large double door on the left side and a single door on the right side permit the easy and rapid loading and unloading of bulky cargoes. Crew access is facilitated by a door on each side of the cockpit.

The Twin Otter can be operated under all climatic and terrain conditions; from high altitude plateaus, rudimentary jungle strips, small bodies of water, ice or snow surfaces. Quick change versions of this aircraft from landplane to seaplane to ski-plane make these varying operating conditions possible.

The low and slow flying ability of the Twin Otter allows exceptional accuracy for close controlled drops of both cargo and personnel when it is expedient not to land. This same inherent design feature is particularly significant when a military mission requires the ability to fly below radar coverage.

This aeroplane will serve most effectively where low traffic density and the lack of conventional airport facilities inhibit the use of large aircraft or conventional aircraft in the Twin Otter's weight category.



## THE BUFFALO

The DHC5 Buffalo, designed, developed and in production by de Havilland Aircraft of Canada, represents the refinements of twenty years of proven experience in the STOL field.

Applying the standard 50 ft (15 m) obstacle an improvised strip of only 1490 ft (454 m) is required for operation. From such rudimentary airstrips the following operations are possible:

- 13,843 lbs (6,229 kg) for 440 nm (815 km)
- 8,000 lbs (3,629 kg) for 1,320 nm (2,450 km)
- 4,000 lbs (1,814 kg) for 1,885 nm (3,493 km)

The Buffalo achieves these performances by twin T64 propeller turbine engines each rated at 3,068 e.s.h.p.

This aeroplane offers a world-wide self-deployment capability, which is a prime consideration in situations where the rapid availability of aircraft to meet emergency military situations, natural disasters or where low cost commercial transportation is vital. Equipped with long range bag tanks, the Buffalo has a non-stop range of up to 3893 nm (7210 km) flying at 25,000 ft (7620 m). The bag tanks, used for the ferry flight, can be employed in the mission area to serve for aircraft and ground equipment refuelling.

As a troop transport, the Buffalo seats 41 fully equipped troopers or 35 paratroopers. Troops can be landed in the combat zone and deployed rapidly through the rear loading door or paraded into critical areas. For casualty evacuation 24 litters and seats for 6 attendants can be accommodated. For government administration or commercial passenger service, 40 passengers in forward facing seats can be accommodated and this configuration includes wash room, food and beverage dispensing facilities. A utility version seats 43.

The DHC 5 Buffalo Development Programme was jointly financed on an equal share basis by the United States and Canadian governments and de Havilland Aircraft of Canada Limited. The 4 prototypes now flying have received certification and have been subjected to intensive military effectiveness evaluation programmes, with two having been tested under actual warfare conditions in Vietnam. Deliveries of production models of this aircraft are scheduled to begin early in 1967.







## THE TURBO-BEAVER

De Havilland Aircraft of Canada Limited have developed an advanced version of the already world wide accepted Beaver aircraft. Th's new aeroplane, the Turbo-Beaver, has retained the rugged structural simplicity and mission versatility of the standard Beaver. This advanced version, while offering turbine power in greater payload capacity, still maintains the short field take-off and landing characteristics which were an inherent design feature of the basic aircraft.

The Turbo-Beaver is powered by a Canadian Pratt & Whitney PT6A-6 single stage free power turbine engine which uses a variety of low grade aviation fuels, effecting a substantial saving in operating costs. Cold weather starting ease is another significant advantage of this aeroplane for winter bush or arctic operations.

The Turbo-Beaver will carry 8 passengers and baggage, or a 1780 lb. (807 kg.) cargo over a stage range of 300 miles (482 km.). It is quickly and easily adapted to wheel, float, ski, wheel/ski or to amphibious gear. The cabin dimensions are 122" x 43" x 46" (310 x 109 x 117 cm) and the access dcors are designed for easy loading and off-loading of bulky items. Conversions from passenger to cargo or ambulance interior configurations can be quickly effected.

STOL (Short Take-off and Landing) capabilities are traditional in aeroplanes of DHC design. The Turbo-Beaver will take-off to clear a fifty foot obstacle (15.24m), full gross weight 5370 lbs. (2436 kg.), zero wind, in 1030 feet (314m) and lands under the same conditions in 880 feet (268 m). Its cruising speed is 163 mph. (262 km/hr.) at 10,000 ft. (3050 m).

The standard Beaver, which is now flying in some 65 countries, established de Havilland Canada's leadership in the STOL utility aircraft design and development field. Turbo-Beavers are now maintaining this leadership and are being employed from the tropics to the Arctic on a variety of missions, ranging from air ambulance service in Iran to air charter service in Alaska. Countries where Turbo-Beavers are now flying include:- Canada, United States, Australia, Costa Rica, Sweden and Iran.



## **CANADAIR CL-84**

The CL-84 is being developed as a highly versatile vehicle with the potential of fulfilling a wide variety of roles that otherwise require the use of both fixed and rotary-wing aircraft. Its military applications are expected to comprise combat support, personnel and cargo transport, reconnaissance, search and rescue, helicopter escort, and communications, from both land bases and aircraft carriers.

Performance flexibility of this order is made possible by the novel "tilt-wing" design of the CL-84 which allows the aircraft to take off vertically and hover like a helicopter, yet fly forward like an airplane at speeds up to 350 m.p.h. (563 km/hr). With the wing tilted between the vertical and horizontal, the CL-84 will have impressive performance and manoeuvrability at very low speeds and outstanding short take-off and landing (STOL) capabilities.

Although this aircraft is designed for vertical, STOL, and fixed-wing flight, the pilot's primary cockpit controls consist of the standard aeroplane rudder pedals, stick, and single throttle (power lever) which incorporates the wing-tilt switch. (There is no requirement for a collective pitch lever). Because of this simplicity, an experienced pilot will be able to devote virtually his full attention to his operational task rather than to flying the aircraft.

Commercial developments of the Canadair CL-84 would substantially reduce total travel time for passenger transportation between city-centres 100 to 500 miles (161 to 805 km) apart. Also, because such aircraft can operate independent of normal runways, they have considerable potential for survey, exploration and general transport work in undeveloped areas.

## **CANADAIR CL-89                      (AN/USD-501)**

The Canadair CL-89 has the service designation 'Drone System, Short-Range Reconnaissance XC1', and performs the functions of target acquisition, damage assessment and surveillance.

The CL-89/XC1 is a self-contained, mobile system which is based on the use of a simple, low-cost drone that carries sensor equipment and is recoverable. It is for day and night use by army formations in forward battle areas.

The drone is launched by booster rocket and has a turbojet sustainer engine. On completion of a reconnaissance mission, it returns and lands by parachute, with air bags to cushion ground impact. The drone is then available for further missions.

Development of the CL-89/XC1 system is funded jointly by the British, German and Canadian governments, with the U.S. Army providing firing-range facilities and technical support for the flight-test program.







## **CANADAIR CL-41A TUTOR**

Complete pilot training from first flight through to operational level is practical with the CL-41A Tutor, now in service with the Royal Canadian Air Force, Training Command and scheduled to go in service with the Royal Malaysian Air Force in the spring of 1967. The aircraft has a performance that ranges from 80 to 488 mph (129 to 785 km/hr.), thereby providing good slow flight characteristics for the new student and high speed training for the advanced student. The service ceiling of 43,200 ft. (13,167m) provides ample range for training and operational flying. The side-by-side seating arrangement permits excellent visual instruction techniques between the instructor and student.

Construction features of the CL-41A include a very robust airframe structure designed for long service life; a spacious, pressurized and airconditioned cockpit; very good harmony of flying controls throughout the wide speed-range; wide-track undercarriage with nose wheel steering; and superior cockpit visibility.

The CL-41A is considered to be an excellent basic and/or advanced jet trainer for both military and civil pilots.

## **CANADAIR CL-41G TACTICAL TRAINER**

The CL-41G has been developed from the CL-41A Tutor. As an operational trainer or counter-insurgency aircraft, the CL-41G is capable of multi-mission versatility maintaining the very good construction features of the Tutor trainer mentioned above. The CL-41G can carry a 3,500 lb. (1587.6 kg) load of ordnance stores on two underfuselage mountings and four under-wing hardpoints. Various mixes of stores can be mounted, including 250 and 500 lb. (113.4 & 226.8 kg) bombs, G. E. Minigun six-barrel machine-gun pods, 500 and 750 lb. (226.8 & 340.2 kg) napalm bombs, and a variety of air-to-surface rockets.

High aircraft utilization rates are achieved as a result of the special attention that was given in designing the aircraft to ease of servicing and maintenance. There are over 50 panels provided for access to the airframe and engine, and the major portion of flight control runs, hydraulic lines and electrical cables are easily reached in a large trough in the bottom of the fuselage. The G.E. J85-CAN 40 engine, common to both the CL-41A and 41G is widely used in civil and military aircraft.

Growth potential for the CL-41G includes additional fuel tanks for increased range, pod mounted reconnaissance equipment, and increased flexibility through multi-purpose armament hardpoints.



## THE DHC-4 CARIBOU

The Caribou, designed and built by de Havilland Aircraft of Canada Limited, serves as a tactical military air transport aircraft or for off-airway commercial application. Powered by two P. & W. R-2000 engines, its most outstanding characteristic is a combination of STOL (Short Take-Off and Landing) capability and exceptional control at low altitudes and slow speed. At a gross weight of 28,500 lbs. (12,927 kg.) the Caribou will take off to clear a 50 ft. (15.24 m.) obstacle (zero wind) in 1185 feet (361 m.) and land in 1285 feet (392 m.).

In the course of U.S. Army evaluation trials, the Caribou's capability for short, rough field take-off and landing was strikingly demonstrated by a take-off from a field that had been ploughed to a depth of 14 inches (35.5 cm) and then thoroughly soaked. The aircraft also landed successfully in this morass. In further trials it demonstrated excellent capabilities for Ground Proximity cargo and vehicle delivery operations.

The Caribou's cabin is generously proportioned; length, 345 ins. (876 cm) width at floor, 73.5 ins. (187 cm); max. width, 87 ins. (221 cm); height, 75 ins. (190 cm). It has a cargo capacity of 4 tons (3629 kg) and will accommodate 32 troops, 24 fully equipped paratroops, or 32 passengers in the civil utility transport version. For aeromedical evacuation applications it accommodates 20 litters and 2 seats.

The high, wide rear cargo door and convenient adjustable ramp arrangement facilitates rapid loading and off-loading of cargo. Military vehicles, such as cargo carriers, half-ton weapons carriers and the Lacrosse Missile, mounted on a trailer, can be moved into and out of the cabin easily.

The Caribou is the third D.H. Canada designed and built STOL transport 'plane. The DHC2 Beaver, which made its debut in 1947, was designed to meet the specific needs of Canadian bush aviation: short, rough field take-off and landing capabilities, simplicity of design to facilitate ease of maintenance under difficult conditions, and structural sturdiness, all combined with a substantial payload capacity. The Beaver met all these requirements and it was soon known as "the half-ton flying truck". The DHC-3 Otter, which followed the Beaver into the air in 1951, was in fact a big Beaver combining Beaver performance characteristics with double the payload and a longer range. Today, Beavers and Otters are serving the military and civil utility air transport needs of some 65 nations and the characteristics that have won them world respect have come to the Caribou as a natural inheritance.

These aircraft are now flying with the following Services: U.S.A.F., U.N.E.F., R.C.A.F., R.A.A.F., India, Malaysia, Ghana, Zambia, Kenya, Tanzania, Kuwait. While Uganda and Thailand employ the Caribou under administrative and police work the Mandated Airlines of Australia use it on a schedule service to New Guinea and Papua while air charters fly from Taiwan. The success of the aircraft is ensured by a delivery of 253 to date.







## AMPHIBIOUS UTILITY TRANSPORT CL-215

The Canadair CL-215 is a twin-engined amphibian of simple design combining a rugged structure with a substantial reserve of engine power and good low-speed handling characteristics. These features when associated with control harmony at all speeds, ease of operation and maintenance ensure an aircraft which will be capable of undertaking a variety of utility transport roles as well as special purpose duties for both civil and military users.

There are various basic configurations for the aircraft, some of which will be considered here:

- As an aerial fire control or water tanker the CL-215 is the first airplane to be designed for the task of fighting forest or other type of ground fires from the air by the technique known as "water bombing".
- As a commercial transport the CL-215 meets civil airworthiness requirements (as defined by U.S. Federal Aviation Regulations Part 25) for passenger carrying. The aircraft carries 32 passengers or 8,000 lbs (3,660 kg.) of cargo.
- Good low-speed handling characteristics and generous cargo capacity of the CL-215 make it a very suitable platform for air-dropping of supplies and animal feed in times of local emergency or disaster.
- Low cost and economy of operation make the CL-215 first choice for such specialized duties as aerial survey, geological prospecting, flying hospital, coast guard patrol and air/sea rescue.

A soft tire landing gear makes the aircraft independent of hard-surfaced runways and provides great flexibility of operation, whether land or water based. As a flying boat, the CL-215 may be operated in sea conditions with waves up to 4 ft. (1.2 m.) in height. These features make the amphibious CL-215 the logical successor to the Catalina (PBY-5A) or Albatross (HU-16) for reconnaissance, patrol, escort, rescue, casualty evacuation, anti-submarine warfare and other military roles.

Twenty of these aircraft are now flying in the Province of Quebec as aerial tankers in the Forestry Service while an additional 10 of the same version have been purchased by France. Some 12 other countries, including the United States, Germany and Australia, have an active interest in the aircraft.

### GENERAL DATA

The following general data is applicable to a "standard" version of the aircraft. It will be realized that various modes will have differing performance figures.

Power plant: two Pratt & Whitney R.2800 engines 2,100 B.H.P.

### DIMENSIONS

Span	93 ft. 10 ins (28.6 m)
Length	63 ft. 6.6 ins (19.3 m)
Height	27 ft. 2 ins (8.2 m)
Tail Span	36 ft. (10.97 m)
Wing Area	1,080 sq. ft. (100 sq. m)

### WEIGHTS

Operating Weight, Empty	25,000 lb. (11,340 kg)
Zero Fuel Weight	37,000 lb. (16,783 kg)
Take-off Weight — Maximum	41,500 lb. (18,824 kg)
Maximum Payload	12,000 lb. (5,443 kg)
Maximum Fuel Load	6,500 lb. (2,948 kg)
Maximum Landing Weight	33,400 lb. (15,150 kg)

### PERFORMANCE

Cruising speed, normal power	185 m.p.h. (298 k/h)
Take-off distance to 50 ft. (15.2 m) at 35,000 lb (15,876 kg)	2,070 ft. water (630 m)
Take-off distance to 50 ft. (15.2 m) at 41,500 lb (18,824 kg)	2,640 ft. land (804 m)
Landing distance from 50 ft. (15.2 m) at 33,400 lb (15,150 kg)	2,825 ft. water (861 m)
	2,200 ft. land (670 m)



## GYROPLANE (V/STOL AVIAN 2/180)

The work now in progress throughout the world on gyroplane development is nowhere more advanced than the AVIAN project at Georgetown, Ontario.

Although at first glance there seems to be a great similarity between the helicopter and the gyroplane, the principles of flight and control are quite different. One of the chief advantages of the Gyroplane over the Helicopter is the fact that only a few hours of conversion are required for a fixed wing pilot as opposed to the complete course required for Helicopter pilotage. The airflow through the rotor disk of the helicopter in level flight is from the top side due to the disc being inclined downward to achieve forward motion. On the other hand, the gyroplane lift is obtained by the windmill effect of air passing through the disc from the bottom because the disc is inclined backwards in forward flight. The helicopter rotor has to perform three functions; namely lift, thrust and control, whereas the gyroplane rotor is only called upon for lift and control. The thrust is provided by a conventional engine and propeller configuration. It will be readily appreciated that the complex problems of flight and maintenance inherent in the helicopter are not found in the gyroplane. The performance of a modern gyroplane with jump-start capability makes it as versatile as the helicopter with the exception of the latter's ability to hover, but the dynamics of the gyroplane rotor system permits higher forward speed than obtainable with the helicopter.

Development on the AVIAN 2/180 gyroplane has progressed through five models for the past five years, starting from an elementary open frame design to the sophisticated monocoque construction of today's aircraft. The basic aim has been to keep to as simple a design as possible consistent with good engineering practice. An example of this philosophy is a simple single aluminum strut under-carriage for ease of manufacture, requiring no maintenance.

One of the distinctive features of the aircraft is the ring shroud or duct which encloses the 200 hp Lycoming engine and pusher propeller. In addition to increasing the thrust from a given diameter propeller, the shroud acts as the unit to stabilize the aircraft in pitch and yaw. The rudder mounted inside the shroud gives directional control down to almost zero forward speeds. The rotor has three blades attached to the hub by steel straps. Working in place of thrust bearings, this system gives a rigid rotor necessary for eliminating ground resonance. Further, no drag dampers or hinges are used, making ground adjustment easy since the blades do not go out of track even under severe operating conditions. The feature of the AVIAN 2/180 that qualifies it as a true V/STOL aircraft is its jump-start capability. The system used is basically very simple and has been explored by others with success. The rotor is spun mechanically with the blades in zero pitch while the aircraft is still on the ground. When the rotor has reached a predetermined rpm the pilot pulls the take-off lever smartly upward. This action disengages the mechanical drive while applying  $10^{\circ}$  of positive pitch on the blades. This pitch change plus the kinetic energy stored in the blades is converted to lift and causes the aircraft to jump directly off the ground. When the stored energy is dissipated, the angle of attack is reduced to a pre-set cruise position. The rotor will now auto-rotate under its own power. Except for the jump-start the flying techniques are substantially those used for fixed wing STOL aircraft. Since the rotor is auto-rotating at all times when airborne it is impossible to stall or spin the aircraft. The rotor is in effect a parachute that can be used gently to lower the aircraft to earth.

The prototype aircraft built over the past five years have differed in detail to optimize the final production aircraft built during 1965 for certification in 1967.







## THE PT6/ST6 500-800 SHP TURBINE ENGINE

The PT6 gas turbine engine, a product of United Aircraft of Canada Limited, is setting new standards in the light plane, helicopter, industrial and marine market. Since its first run in February, 1960, the engine has logged over 30,000 test hours, 300,000 flight hours with more than 1000 PT6 engines delivered into the hands of commercial operators. As a reverse flow, free turbine, opposed shaft engine, this advanced design avoids the use of concentric shafting and features an exceptionally low noise level by retaining the high speed aerodynamic components buried well within the engine casings. The plenum type intake makes possible the use of a large area fine mesh screen which is insensitive to both airflow distortion and icing and precludes all foreign object damage.

As a turboprop engine the PT6 is certified with a full reversing control system featuring wide range Beta control suitable for STOL aircraft installations. This free turbine engine is capable of achieving high approach drag, instantaneous reverse thrust and slam accelerations, as well as output shaft speed flexibility for cruise and very low ground idle propeller and engine speeds.

Pilot operation, identical to that of most piston engines, is controlled by a throttle and propeller conditioning lever with power being set by either engine torque or turbine inlet temperature.

PT6 powered aircraft are now in use all over the world, demonstrating "hot day" performance in the Sudan as well as cold weather starting in Alaska. The ease of maintenance and smooth reliable operation make the PT6 equally at home in utility aircraft such as the Pilatus Turbo Porter, Helio Stallion, De Havilland Turbo Beaver, and the Twin Otter as well as in business aircraft such as the Beechcraft King Air, Potez 841 and the Swearingen Merlin II. The PT6 is also the choice for many conversions such as in the American Turbine Engine Company, Aircraft Industries of Canada Limited Beech Conversions and the McKinnon and Alaska Coastal-Ellis Grumman Goose Conversion.

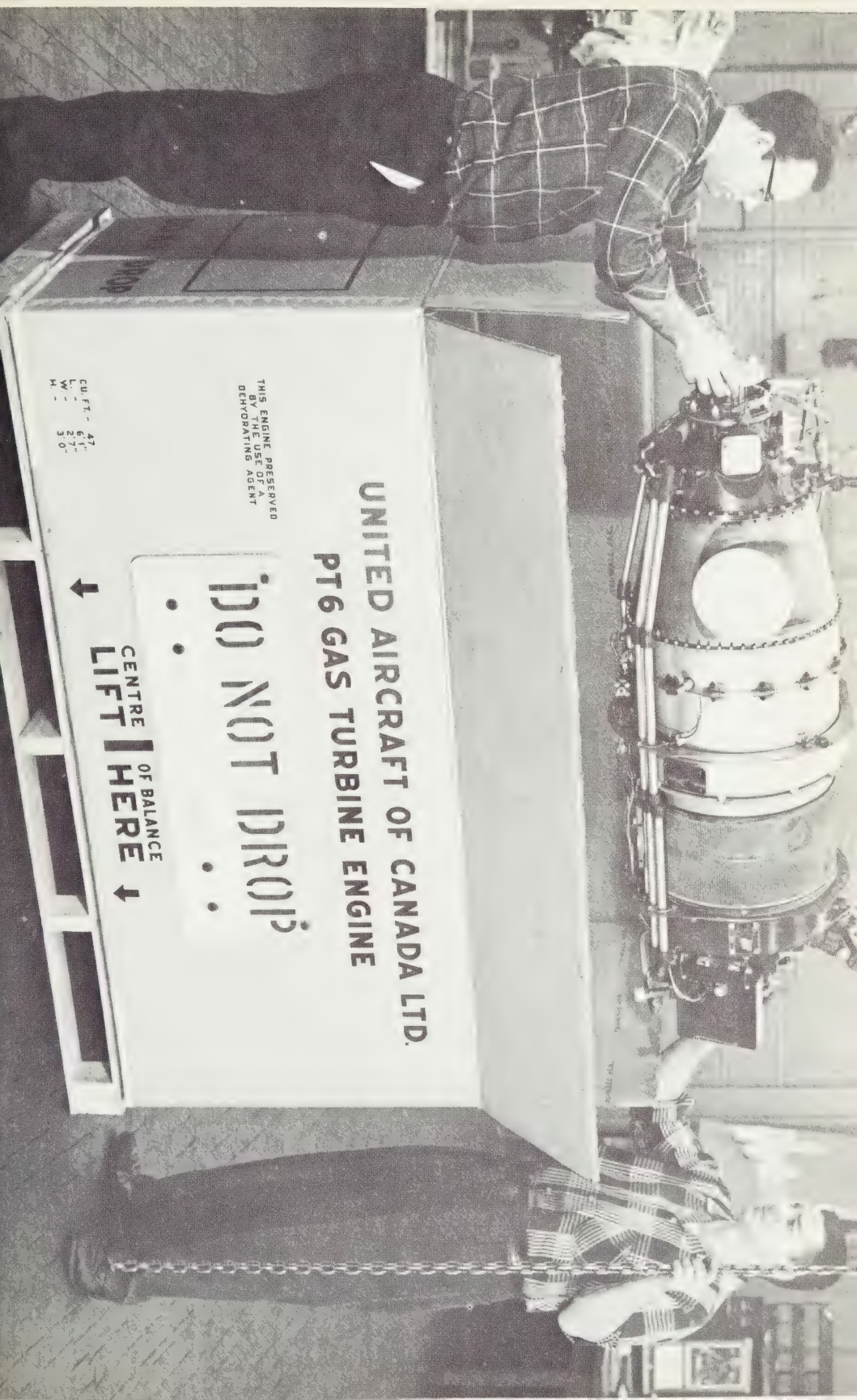
The PT6 may also be found in the following roles:—

- The power plant for the Lockheed rigid rotor Model 286 as well as other helicopter certifications.
- The Beech U21A used by the U.S. Army for the "Tactical Utility" role and also operates in the Presidential Fleet.
- PT6 — designated the YT-74 by the U.S. Military — has operated in both the Convair Charger and North American OV-10-A counter insurgency aircraft.
- The YT-74 has completed preliminary Flight Rating Tests at 650 and 750 SHP Military Ratings for BuWeps.

The marked superiority of the ST6 over conventional power plants is emphasized by the large variety of applications both stationary and mobile in which it is employed.

- Operating as a stationary power supply for a pulpwood chipper in a remote forest location.
- A power source for the 350 KW emergency standby generator.
- Four ST6's being used by the Halliburton Company as a portable 2000 h.p. source for an oil well fracturing unit where the light weight of the engines allows on and off highway transport.
- Approved by US BuShips as a marine gas turbine for prime propulsion following more than 1000 hours of trials in a high speed launch.
- As a prime power supply in high speed snowplows.
- The ST6 has been chosen to power high speed trains for the U.S. Department of Commerce as well as for Canadian railways.

Continuing development at United Aircraft will assure optimum performance as well as the continued acceptance of the PT6/ST6.



THIS ENGINE PRESERVED  
BY THE USE AGENT  
DEHYDRATING AGENT

UNITED AIRCRAFT OF CANADA LTD.  
PT6 GAS TURBINE ENGINE

DO NOT DROP

↑  
CENTRE OF BALANCE  
LIFT HERE  
↑

CU. FT. - 47  
L. - 61"  
W. - 27"  
H. - 30"



## WING ACTUATOR SYSTEMS

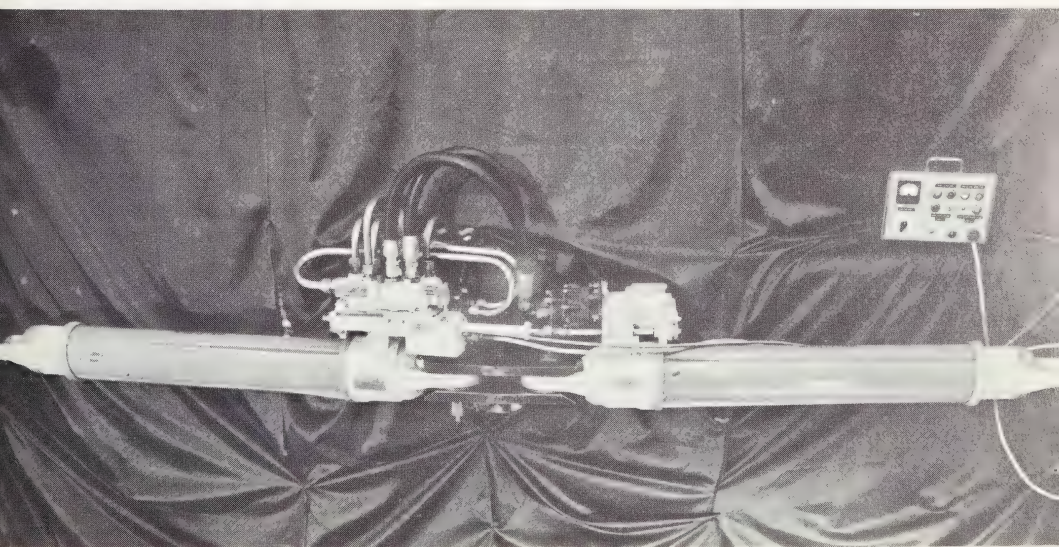
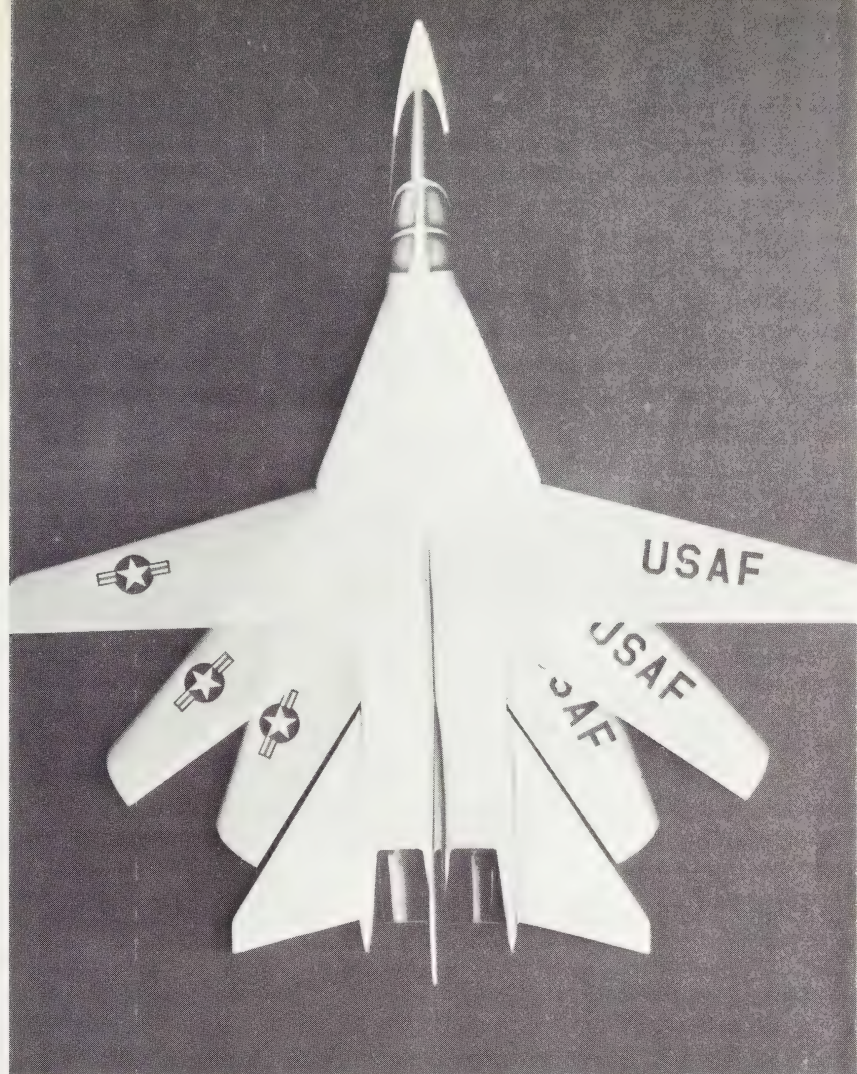
Abex Industries of Canada Ltd., Jarry Hydraulics Division's experience relative to the manufacture of actuators for use in variable geometry aircraft dates back to the Ling Temco Vought XC-142 aircraft wherein Jarry provided the wing incidence actuator. Jarry is also providing the wing tilt actuator for the Canadair CL-84 DYNAVERT aircraft. In providing the wing sweep actuator for the F-111 system, Jarry Hydraulics has established itself as a leader in the field of wing actuators and systems.

The wing sweep actuation system consists of two (2) ACME screw linear actuators, two (2) hydraulic motors, two (2) motor driven gear boxes interconnected by a synchronizing shaft. One gear box has a feedback drive leading to the control mechanism. The control mechanism though originally provided by Jarry Hydraulics is not now a part of the end item.

The pilot operates the mechanism by a pistol gripped sliding lever through a control cable. Two (2) Kellogg motors of the AM series are utilized to drive the system. These motors are provided by our Kellogg Division and therefore considered part of the end item. The gear box utilizes a planetary gear system to obtain the required reduction. The high speed part of the gear box is splash lubricated using MIL-L-7808E lubricating oil, aircraft engine, synthetic base, with a service temperature range of -65 degrees to 350 degrees F. The low speed part of the gear box is initially buttered with grease and can be relubricated by means of pressure gun fittings using MIL-G-23827 grease, aircraft gear and actuator screw, for low and high temperatures. Positive mechanical synchronization is effected by means of a synchronizing shaft which is driven by the hydraulic-motor shaft via idler gears.

The jack screws have a four start left hand ACME thread. The jack screw and main gear are forged in one piece. Terminal bearings are of the single ball self aligning type. Incorporated in the actuator is a thrust bearing designed to deflect under load and after this deflection the applied load by-passes the thrust bearing and is reacted through the structure in which case the actuator will stall out. Solid stops are provided at each end of travel. A metal dust cover is provided to protect the ACME screw from dust, etc. Lubrication of the jack screw is effected by coating the screw with Teflon. Irreversibility of the actuator is accomplished by the helix of the ACME screw. Pre-selection of wing position is transmitted via the control mechanism to the servo valve input. Movement of the servo valve spool ports system pressure to the hydraulic motors which through the gear boxes drive the screws to extend or retract the actuator. A feedback device makes the actuator movement correspond exactly with the pilot input. Backlash throughout the entire system is minimum and units are synchronized to within .020". To drive the group at maximum rate and load, 61 gpm U.S. at 3000 psi hydraulic power is required. Each actuator is approximately 56" long retracted, has a stroke of 31", and weighs about 166 lbs. To safeguard the systems, the drives are designed so that in the case of one failing, the other does the work of both.

Abex Industries have also designed, developed and manufactured the main landing gear for the DHC-5 Buffalo. The characteristics of this gear contribute greatly to the exceptionally fine STOL performance of that aircraft. Hydraulic systems or controls and other actuators are designed and developed here to meet the demands of to-day's modern aircraft and missiles.





## MAIN LANDING GEAR FOR TUTOR AIRCRAFT

The main landing gear for the RCAF CL41A Tutor jet trainer was designed and is currently produced by Dowty Equipment of Canada for Canadair Limited, Montreal.

Of simple design, the gear incorporates a conventional type air/oil shock absorption element. Main components comprise an anodized aluminum alloy main outer cylinder, a steel cylinder assembly, and steel torque links which are mounted between the main outer fitting and the sliding cylinder assembly. The wheel axle component and the sliding cylinder are machined from a single forging.

Air under pressure is contained in the bore of the sliding cylinder, while the bore of the main outer fitting is filled with hydraulic fluid. A floating piston separates the air from the fluid. In operation, the sliding cylinder telescopes into the main outer cylinder. Movement between these cylinders causes fluid to be forced through a valve in the piston head of the sliding cylinder to damp impact shocks. At the same time, air below the separator piston is further compressed; it is this 'air cushion' upon which the aircraft rides during take-off and landing runs and taxiing.

Salient characteristics: *Weight* 51.3 lb. approx. (23.3 kg); *Temperature range* -65°F to 275°F. (-18C to + 135C); *Fluid* MIL—H—5606.

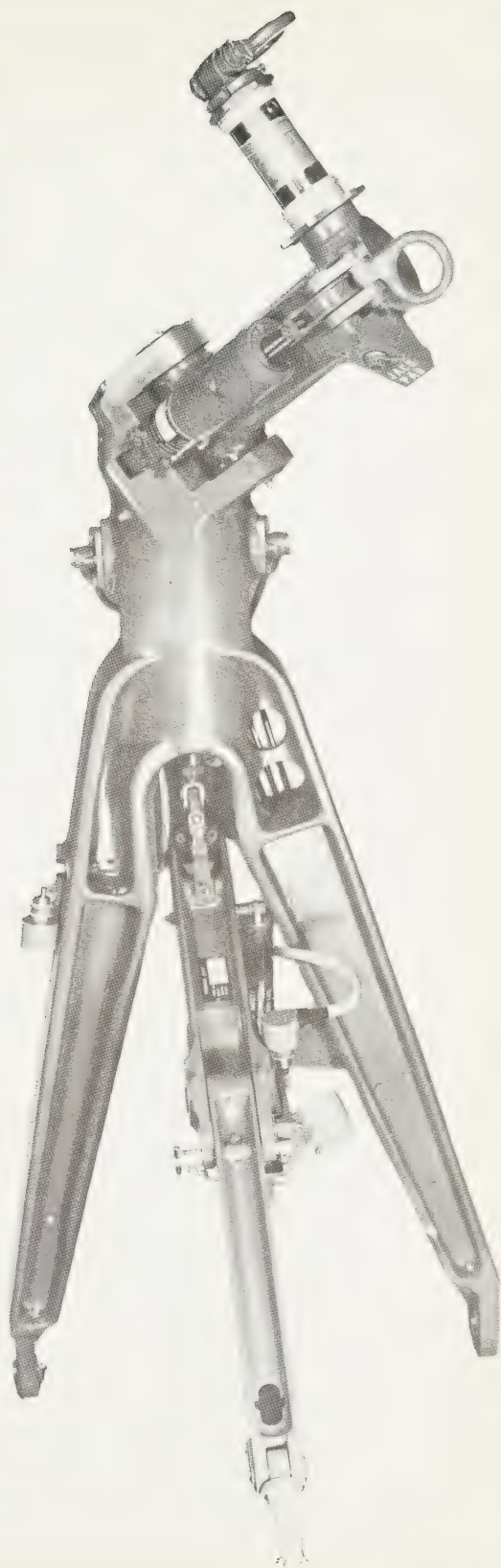
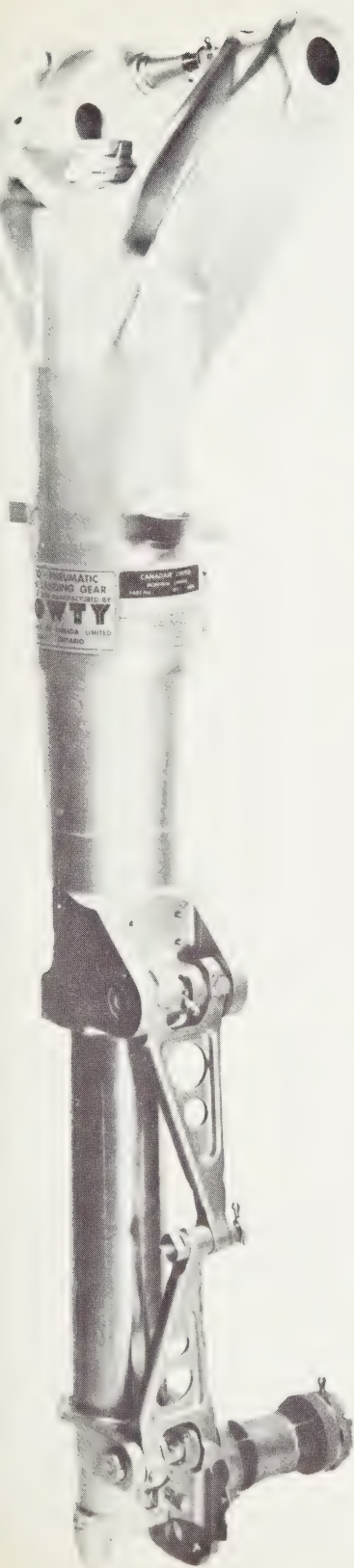
## HELICOPTER LANDING GEAR

The wheeled main landing gear used on the Navy model UH-2 Helicopter was designed, developed and produced by Dowty Equipment of Canada Limited for Kaman Aircraft Corporation, Bloomfield, Connecticut.

Constructed predominantly of aluminum alloy, anodized, with a link and axle member machined from one steel forging, the gear is fully retractable. Compact, yet readily serviced, the gear is attached to aircraft pick-ups at the main 'Y' member extremities and at the drag strut swivel. Extension and retraction is accomplished by means of a hydraulic actuator housed within the bore of the main member. An internal claw-type lock within the actuator locks the gear upon full extension; an uplatch affixed to the aircraft fuselage contains the gear in its retracted position. A spring-box is incorporated to assist normal extension of the gear and to ensure emergency full extension. Operational shocks imposed on the gear are absorbed by a Dowty 'Liquid Spring' shock absorbed mounted between the link and axle member and the main 'Y' member.

Aircraft towing and tie-down eyes are embodied.

Salient characteristics: *Weight* 92½ lb. approx. (42 kg); *Temperature range* -65°F to 160°F. (-18C to + 71.1C); *Fluid* MIL—H—5606.



## FLAP ACTUATOR/CONTROL

Designed and manufactured by Dowty Equipment of Canada for the operation and control of the De Havilland Caribou wing flaps, this unit comprises a double-acting hydraulic actuator and a spool type control valve with an interconnecting mechanism to cancel the selected flow path when the desired actuator traverse has been reached. Other elements embodied include an internal lock which sustains the actuator in its closed state, an inlet filter and check valve, a rotary shut-off valve and a pressure relief valve.

Control is normally effected through push-pull linkage from the cockpit control to the external lever of the actuator. Upon selection of the desired degree of traverse, hydraulic pressure to the locked actuator causes the lock to disengage and permit piston movement. A spiralled rod connected to the rotary shut-off valve is rotated by the moving piston until the flow of pressure fluid is stopped. In this condition the actuator piston travel is also stopped. Return fluid flows through a drilling down the centre of the spiralled rod and to return line via the control valve.

Characteristics of this model:

Weight .....	20 lb. (9 Kg.)
Maximum output force	
—Retraction .....	2310 lb. at 3000 p.s.i.
—Extension .....	7620 lb. at 3000 p.s.i.
No-load operating time	
—Extension .....	20/25 secs.
—Retraction .....	35/40 secs.
Input power requirement .....	3000 p.s.i. working pressure
Shaft stroke .....	12.29 inches maximum (31.2 cm)
Temperature Range .....	-65°F to + 160°F (-18C to + 71.1C)
Fluid .....	Hydraulic oil to Specification MIL-H-5606.

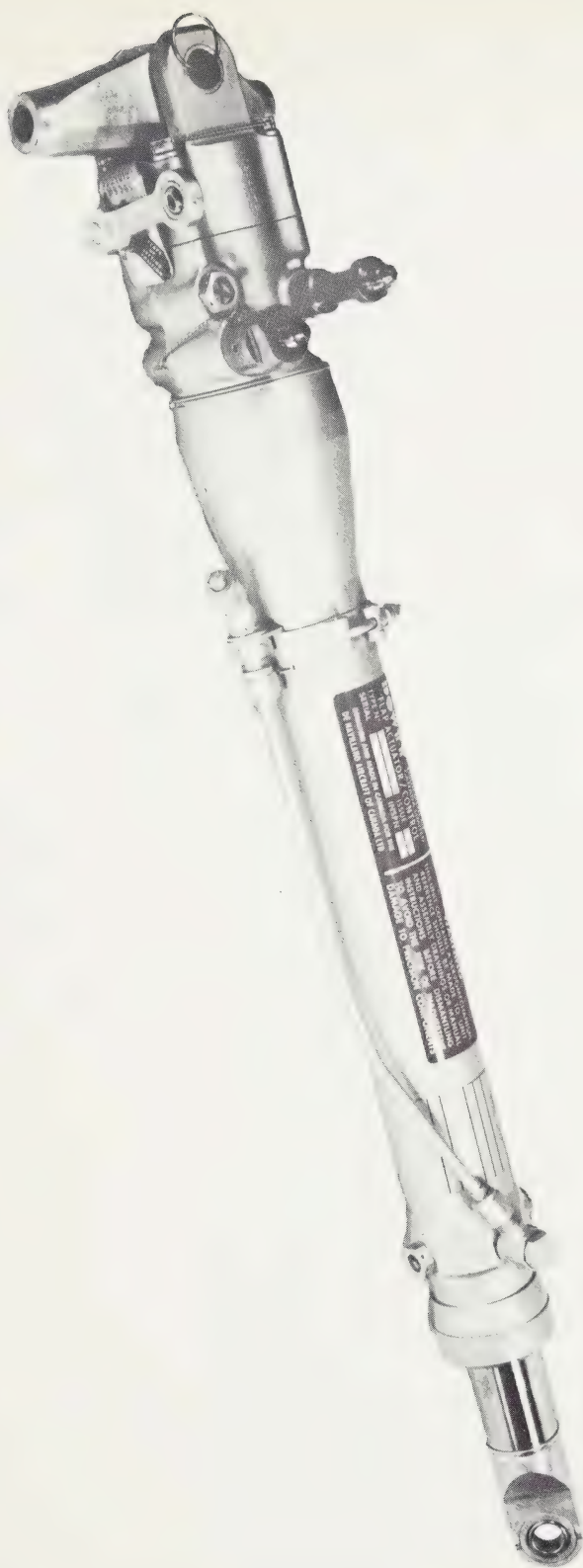
## TWO POSITION NOSE LANDING GEAR—CF-5A

The nose landing gear for the Northrop Norair CF-5A jet fighter is designed by Dowty Equipment of Canada Limited. The gear is currently in production for both Northrop and Canadair Limited, Montreal. The latter is constructing the Canadian version of the Northrop Norair F5 Aircraft, the CF-5A. The first landing gears will be delivered in August 1967.

The landing gear incorporates a wheel fork and axle assembly attached to an oleo-pneumatic shock absorber which telescopes together with an auxiliary outer tube in the nose gear main fitting. A design feature of the gear is a lengthening device which enables the pilot to lift the aircraft nose and increase the aircraft angle of attack, thus decreasing the take-off distance. The lengthening device, in essence an hydraulic actuator, consists of a piston on the auxiliary tube which acts in the bore of the gear main fitting under normal aircraft system hydraulic pressure. A splined tube within the main fitting prevents rotation when the gear is shortened for stowage after take-off.

Torque arms connect the wheel fork assembly to a steering collar on the gear main housing and a quick-release pin is provided at the torque arm knee-joint to allow for towing of the aircraft. Provision for a nose wheel steering actuator attachment is made via a lug on the steering collar. An internal centering mechanism maintains the nose wheel fore and aft when off the ground. The landing gear main fitting is manufactured from aluminum alloy and the remaining component parts, including the torque arms, are steel: Design Characteristics:

Weight:	73 lb. (33 Kg.)
Length fully extended:	51.50 inches (130.81 cm)
Length shortened for stowage:	40.00 inches (101.60 cm)





## AIRCRAFT RUBBER FUEL CELLS

The importance of "Leak Proof" fuel containers is recognized by designers and manufacturers of all types of aircraft. Pilots, too, appreciate the extra assurance of knowing that their fuel is securely stored.

Rubber Fuel Cells have provided this assurance for many years. Light-weight, flexible, easy-to-install and tested over many thousands of hours of flight, rubber cells have been established as the most reliable fuel containers available today.

Uniroyal (1966) Ltd. has been in this business since 1942. Hard work and high quality standards, backed up by many years of experience and expert engineering skills, have established this Company as a leading manufacturer of both aircraft and vehicle rubber fuel containers.

Their cells are being used in most military aircraft flying today, including: CF-100; CF-104; CF-105; CL-28; CL-41; CL-44; CL-66; CL-94; F-86; F-104D/G; F-94; F-9F; F-5A/B; B24; SB 2C-1; T-33; T-34; T-38; XC-142; UH-12E; Caribou; Otter; Beaver and Harvard. They are also used in the vehicles LTV-2 and 3, CL-91, M-113 and T-97.

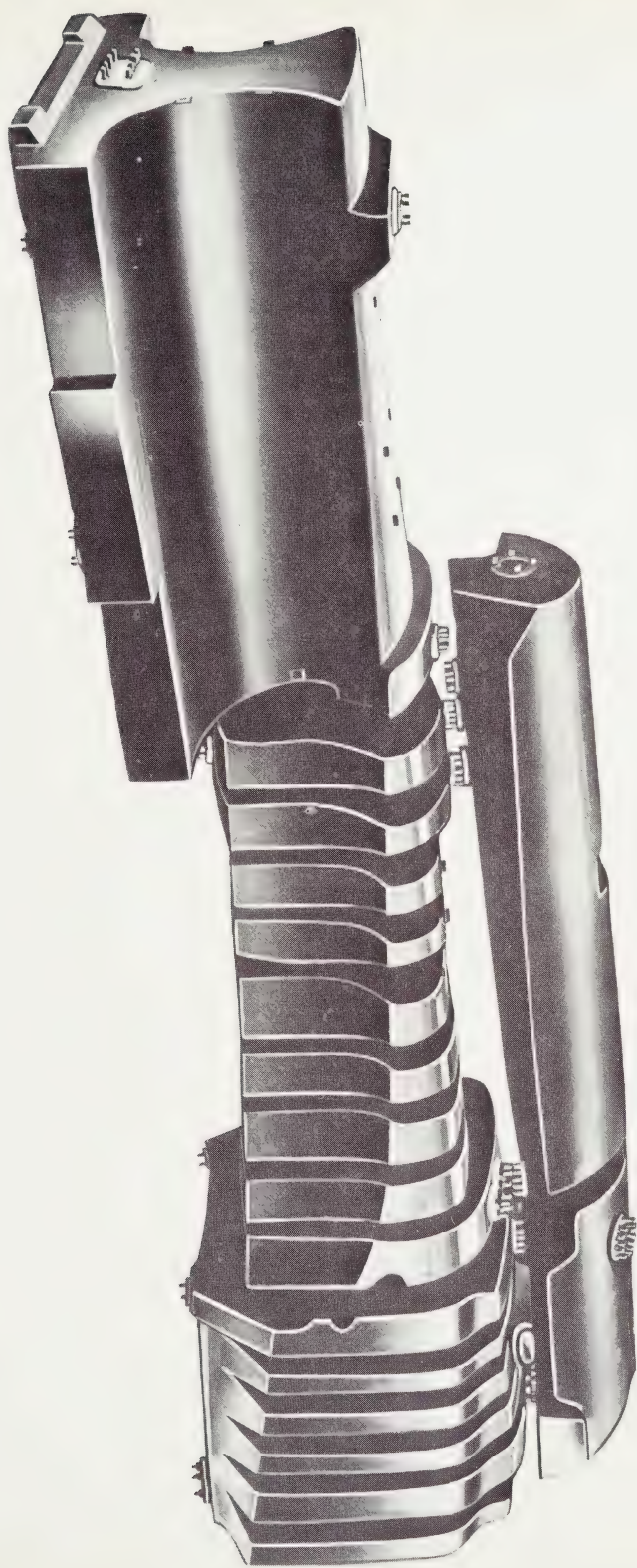
The shape and size of these cells is practically unlimited for they can be tailored to fit into almost any kind of aircraft structure, using stringers and ribs as supports. Fittings and connections are either individually developed, or existing types are utilized. Tight seals are achieved by using "O" rings, gaskets, or plain compression fittings. Cells are held in position by using "hangers", of which a wide variety is available. An average of five or six cells are usually used per aircraft.

The photo on the right illustrates a typical set of T-38 Fuel Cells.

Construction consists of alternate layers of strong nylon fabric, coated with special grades of synthetic rubber to prevent fuel penetration. The range of materials available is very extensive, and can take care of all requirements.

The range extends from flexible light-weight bladder construction, weighing as little as .102 pounds per sq. ft. (46.3 gm. per .092 m<sup>2</sup>) of panel wall to rigid self-sealing constructions, weighing 1.15 pounds per sq. ft. (521.6 gm. per .092 m<sup>2</sup>) which provide protection against .30 and .50 calibre ammunition.

All constructions are produced and qualified to appropriate Military Specifications.



## MAIN LANDING GEAR DHC-5

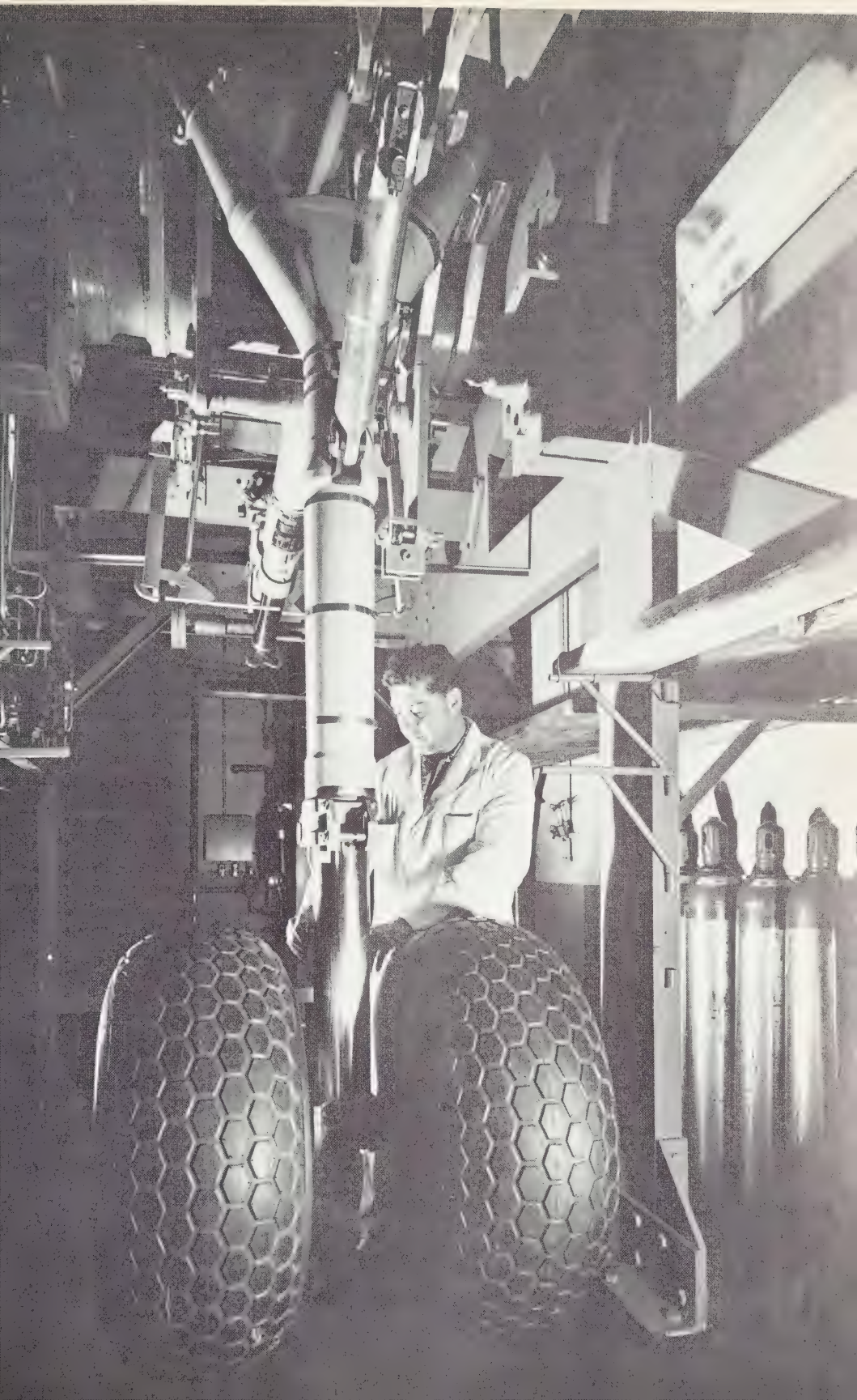
The patented telescoping Landing Gear shown in the adjacent photograph was designed, developed and manufactured by Abex Industries of Canada Ltd., Jarry Hydraulics Division for the de Havilland DHC-5 Buffalo airplane. The gear not only represents an advance in STOL, rough field landing and taxiing capability but its basic design theory was proven as fact in the DHC-4 Caribou.

Abex-Jarry Engineers used a two stage oleo-pneumatic shock strut with overload relief as the basis for their design. This in effect more than satisfies the major design parameters which include: a STOL capability of 13 ft./sec. (4 m/sec) with a reaction factor of 1.8; a stable static platform for loading purposes; and a rough field landing and taxiing capability. The first stage of the two stage strut provides a static loading platform and in conjunction with large tires also provides stable taxiing characteristics under rough field conditions.

The basic strut consists of two stages comprising of main piston, a cylinder, a first stage floating piston, a second stage floating piston, two rebound control devices, a rebound ring and a flapper valve. When the wheels of the airplane contact the ground the main piston moves up relative to the cylinder which is attached to the airplane. This movement forces oil in the strut from the upper side of the piston head through fixed and metering orifices to the lower side. The oil, which is forced through the restricting orifices at a high velocity, causes a pressure drop across the piston thus doing work and absorbing the kinetic energy of the airplane. The oil displaced across the piston head moves the first stage floating piston downward causing it to compress the air in the low pressure chamber of the strut. At the same time some of the oil passes through the rebound chamber entry holes filling this annular chamber with oil. The volume of oil displaced across the piston head causes the first stage floating piston to compress the air in the low pressure chamber to the point where the first stage floating piston impinges on the second stage floating piston. The high pressure air of the second stage is then compressed resulting in a further closure of the strut. Momentarily the vertical motion of the aircraft is brought to a stop, flow through the orifices ceases and pressures in the oil chambers and high pressure air chamber are in equilibrium. At this point the energy which is stored in the compressed air starts to extend the strut. The floating pistons move upward as the air expands thus forcing the oil from the lower side of the piston head to the oil chamber. Two devices are employed to control this rebound. The first is the positive rebound control which restricts the flow of oil forced from the annular chamber as the strut extends. It comprises a rebound ring, a device controlled by inertia, which is held down during compression and moves upwards during the rebound. When the ring is in the extreme upper position it is held thereby by the pressure drop across it and forms a seal with the piston head. Small calibrated orifices in the side of the rebound ring control the flow of oil from the annular chamber thus limiting the speed at which the strut extends. The second device which is employed to control rebound is a flapper valve which is auxiliary to the positive rebound control. The Flapper valve is similar to the rebound ring in that it too is a device controlled by inertia and when moved upwards it restricts the flow of oil back through the orifices in the piston head.

The shock strut also incorporates an overload relief valve which prevents high transient loads from being transferred to the wing structure. It consists of an air pressurized third stage which functions to dissipate high energy by by-passing hydraulic fluid to the low pressure side of the piston head.





## MOBILE AUTOMATIC TEST SET

Developed by the engineering division of Litton Systems (Canada) Limited, the Mobile Automatic Test Set (MATS) is Litton's approach to a rapid maintenance capability employing minimum skill levels for inertial navigation systems at squadron and base shop level. The MATS performs a complete and automatic checkout of Litton Inertial Navigation Systems in aircraft on the flight-line or in the base test laboratory with a minimum of skill and judgement required from the operator. In addition to establishing the serviceability or unserviceability of the system under test, the MATS provides precise information on the nature, location and remedy of a fault, to the extent of isolating a particular module or sub-assembly.

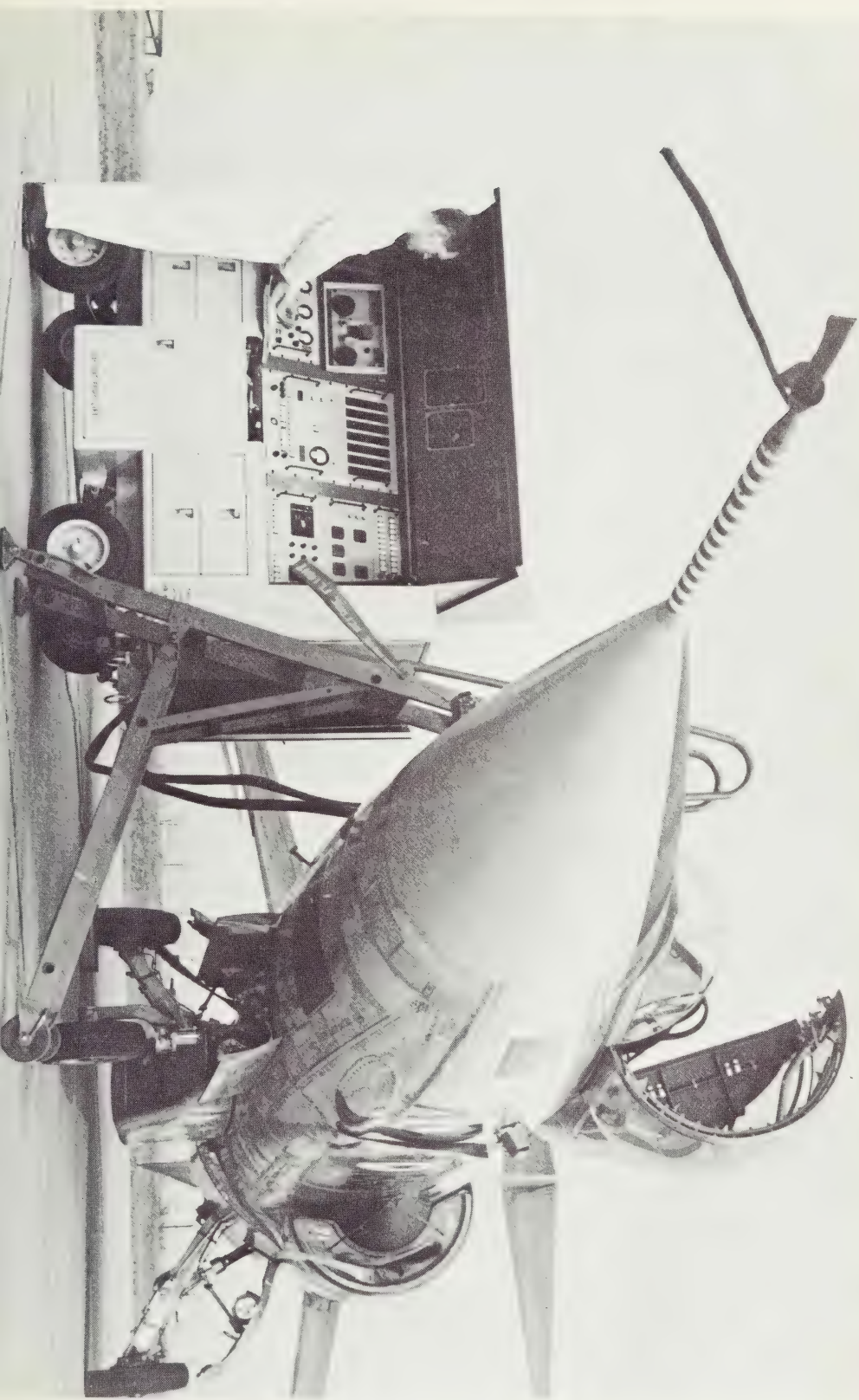
In addition to eliminating unnecessary removals of the guidance system, the MATS makes actual flight checks unnecessary after a malfunction has been corrected by doing a pre-flight confidence check itself.

In the MATS, emphasis has been placed on the convenient grouping of operating controls and displays and on the accessibility of components for easy maintenance. The Test Set is mounted on a chassis having an air-bag suspension to reduce shock loads and is fitted with a tow bar and brakes to assist moving with a tractor. Controls and displays are protected from rain by a hinged shield that can be clamped at any desired angle.

The MATS uses a programmed tape in conjunction with a photo block reader to perform automatic tests. The tape test programs used by Litton MATS can be used for any portion of the inertial navigation system without modification. It is not necessary to change tapes for various types of tests. Additional spare tapes can be punched in the field using inexpensive equipment. Program modification, if required, can be performed with ease. The unit uses relay matrices to select the signals to be tested, their tolerances, and the fault indicator readout instructions. The signal is then compared to an internal reference signal. If the signal is not within specified limits the automatic program is inhibited and the fault indicator readout is energized to indicate the source of the malfunction. A programmed self-test is included to enable the operator to test the MATS immediately, thereby verifying the integrity of the MATS.

Litton MATS vehicles are currently in use with the RCAF, RNLAf and RDAF.







## **“WORTAC” - OVERALL RADAR TESTER AND CALIBRATOR**

WORTAC is a Radar Test and Calibration Set designed and produced by Canadian Westinghouse. As Fire Control Systems become more complex the requirement for the test sets has increased sharply with the realization that simple “go” or “no go” answers are no longer acceptable. Further, the need for pre-flight calibration has also become apparent in modern high speed strike/interception aircraft.

Appreciating this need the company has produced a set which meets all requirements for high accuracy testing, alignment and calibration of a radar directed Fire Control System. Some of the advantages of this system are:

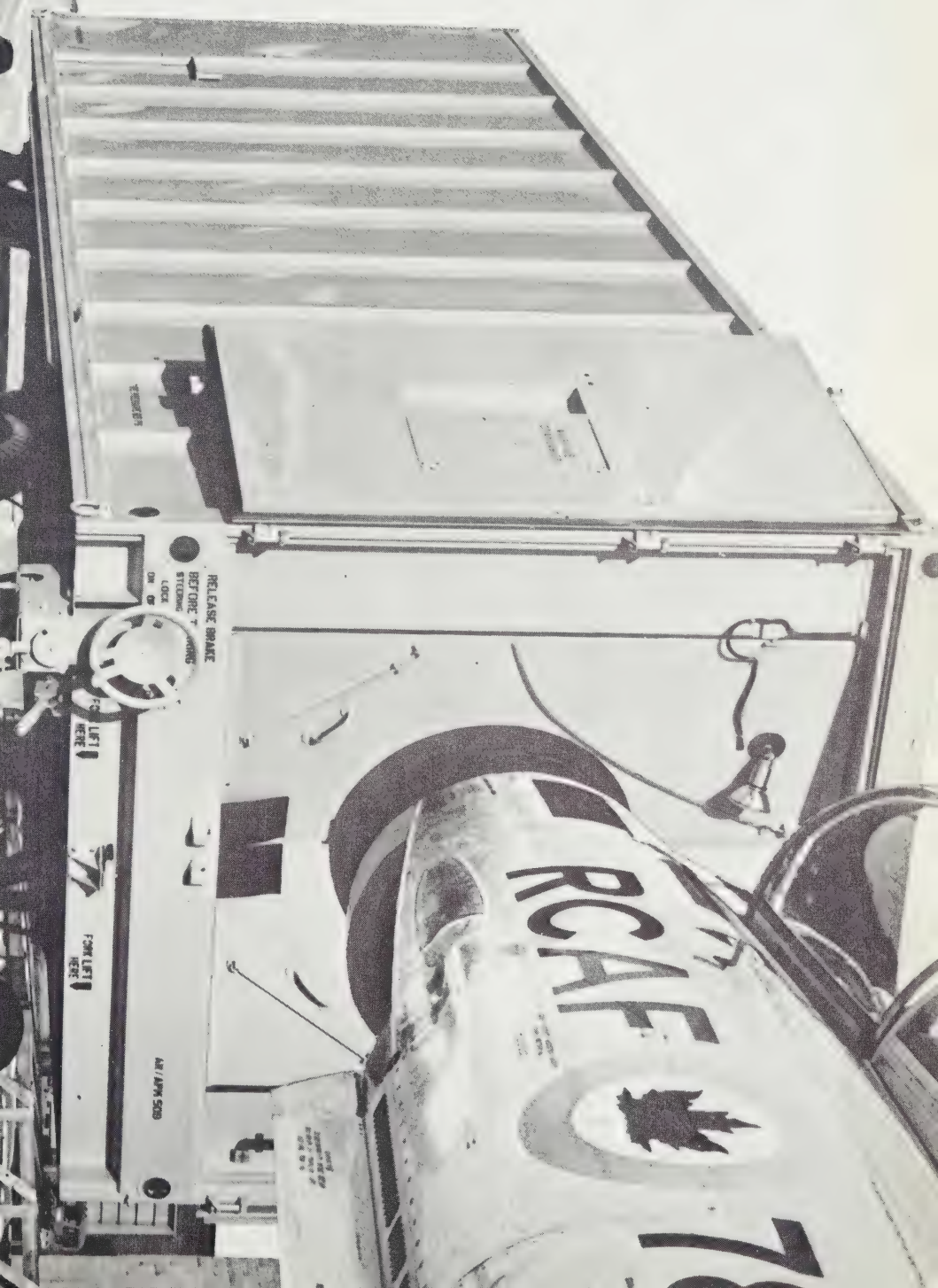
1. It provides a correct simulation of free space.
2. It removes hazard to personnel from radiation.
3. It provides complete end-to-end testing including the tracking of moving targets.
4. It provides accuracy comparable to the best factory test equipment.
5. It is simple to operate and permits flight line testing by a minimum of personnel.
6. It requires no electrical connections to the aircraft.
7. It permits all weather testing.

After considering the above advantages it may be seen that running time on both the radar set and the aircraft have been greatly reduced. This factor also produces advantages: Increased operational life of the system, reduction in maintenance time and repair parts all of which show savings in time and money.

The Dynamic Test Set basically consists of a trailer, a remote control panel, a mechanical alignment system and an electronics cabinet. The size, shape and absorbent lining of the trailer are dictated by the radar set and the accuracy with which test and calibration is required. In addition the all metal exterior of the trailer provides adequate radiation shielding. The remote control panel provides the facility for operating the system while sitting in the cockpit using the radar equipment as it would be used under actual combat use. It facilitates the programming of targets and provides direct read-out indications of the radar sets performance. The mechanical alignment system is so designed that the trailer can be manoeuvred easily into position on the aircraft nose in confined and limited quarters. There is also the facility for comparing the mechanical boresight axis with the electrical boresight axis. This is a very essential operation when high accuracy calibration is necessary. The electronics cabinet is of modular construction and provides the necessary signals and targets of the type, range, velocity and power required by the Fire Control System.

The WORTAC Overall Radar Tester Calibrator is currently being used in the following countries; United States, Canada, Germany, Italy, Belgium, Holland and Japan. The system presently in production is adaptable to most aircraft and Fire Control Systems.

In addition to the design and development of special aerospace ground equipment such as the WORTAC-Overall Radar Tester and Calibrator, Canadian Westinghouse is carrying out research and development in shipboard electronics (including fire control, sonar and torpedoes); airborne electronics (including guidance, control and fusing for air-to-air missiles, fire control systems); communications (including tropospheric scatter); ECM/ECCM techniques as well as solid state displays, remote surveillance devices and antenna and microwave development projects.



## AIRCRAFT SIMULATORS

CAE Industries Ltd. has achieved a position of world leadership in the development and manufacture of Flight, Weapons, ASW and Radar Simulators.

Since 1952 CAE has developed a total of ninety simulators, including thirty-two F-104 Super-Starfighter simulators which are being used to train pilots by the RCAF, USAF and the Air Forces of West Germany, Netherlands, Belgium, Italy, Norway and Denmark.

The simulators, weighing more than 25 tons each, reproduce to a pilot in a ground-based classroom the physical and visual sensations he would experience in flight, thus training him in all procedures and operations from checkout and takeoff to landing, including flight, engines, radar, combat tactics, missile launching and bomb attacks.

Each simulator includes an exact replica of the aircraft cockpit complete with all instruments for control of flight, engines, navigation, radar and weapons. The cockpit rolls and pitches like the actual aircraft and, by means of a unique visual simulation system developed by CAE, the pilot trainee in the cockpit is able to see the horizon and representative targets on the ground as he "flies" the simulator. The visual system also represents airport runways so that the trainee may maintain visual contact during takeoff and landing exercises.

Due to the wide spread use of the F-104 Simulator, it has been chosen as an example of one of the types of simulators produced by CAE.

CAE are capable and ready to meet simulator requirements with respect to other aircraft or equipments.

Between December 1964 and the present, major international airlines ordered flight simulators from CAE. Canadian Pacific Airlines ordered a simulator for the DC-8 Jetliner, Swissair, KLM Royal Dutch Airlines and Iberia Airlines ordered digital simulators for the new DC-9 Jetliner. KLM Royal Dutch Airlines, Iberia Airlines, Air Canada, UTA, and Swissair have ordered digital simulators for DC-8 aircraft.

CAE digital simulators employ General Purpose Digital Computers using silicon monolithic integrated circuits throughout and an all-core memory.

The DC-9 digital simulators in use with Swissair and KLM are the first to be operational in Europe.

*The simulator crew compartment, an exact replica of the aircraft cockpit is complete with actual instruments for control of flight, engines, navigation, radar, and weapons. It is mounted on a base which incorporates a motion system capable of violent movement, and is tied in with a visual system which gives the pilot a moving picture of the airport runway on which he is landing or from which he is taking off. The combination of motion and visual systems is sufficiently realistic to produce airsickness in pilots.*





## CRASH DATA RECORDER

In 1964 both the Royal Canadian Air Force and the United States Air Force raised Contracts with Leigh Instruments Limited to install a Crash Data Recorder/Crash Position Indicator system into the RCAF CC106 "Yukon" aircraft and the USAF C133 "Cargomaster" aircraft, respectively, for evaluation purposes. These particular systems produced analogue recordings, and in each case proved the following features to the user's satisfaction:

- That the recorder was compatible with existing aircraft systems.
- That good quality voice recordings resulted.
- That the aircraft system parameters were faithfully recorded and reproduced.
- That the airfoil deployment system performed satisfactorily, and that the crash position indicating beacon performed to specification.
- That the tape recording survived deployment and landing onto all types of terrain was and totally undamaged.

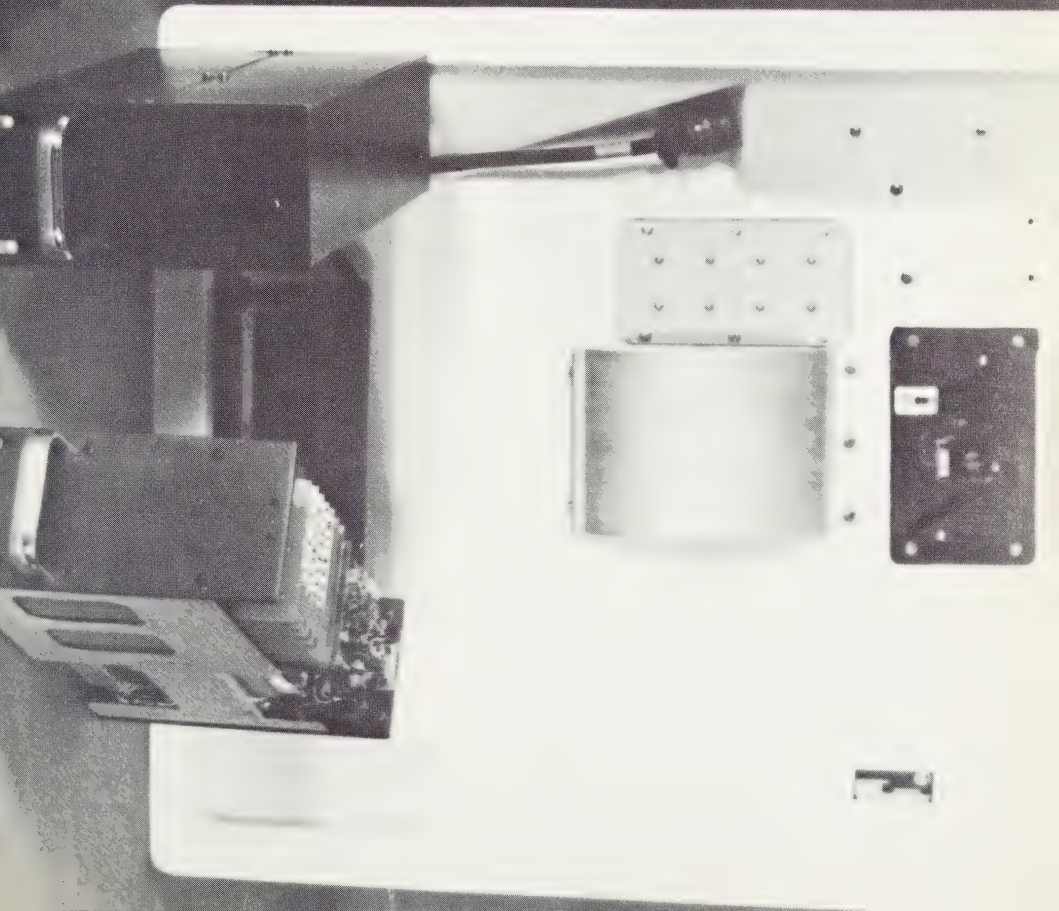
As a result, the RCAF ordered fleet fitment of the CDR/CPI into the CC106 fleet.

The Leigh Instruments Crash Data Recorder will provide a reliable means of recording aircraft flight data and of safely deploying this data upon aircraft crash conditions and automatically transmitting distress signals from the accident scene. Upon location of the airfoil and hence the accident the recorded data may easily be removed from the airfoil and reduced to help determine the cause of the accident.

A pulse duration modulation system is used to record multiplexed data on magnetic tape. This magnetic tape is contained in a cassette which is mounted within the airfoil.

The tape-drive power supply and voice recording amplifiers are integral to the airfoil Mounting Unit and are supplied with the recorder system. The voice recorder sub-system meets the requirements of TSO C84.

DO NOT PAINT





## CRASH POSITION INDICATOR

In the event of an aircraft crash, immediate radio identification of the crash position is highly desirable, in order to provide prompt assistance to survivors and to reduce the cost and hazards of the rescue operation.

Most methods of radio identification have not gained wide acceptance by commercial and private aviation because the available equipment (i) requires manual operation, (ii) in many cases fails to survive the crash, and (iii) is excessive in cost for both initial installation and maintenance. Automatic circuitry has to some extent eliminated the objection of manual operation, but the deployment of the equipment often requires manual removal of the radio beacon from the aircraft. This fact, coupled with the failure of many types of beacons to survive the air crash, has rendered many survival beacons of little value, particularly in single-place aircraft applications.

The Leigh Crash Position Indicator is a distress radio beacon that (i) is automatically released and deployed; (ii) has proven that it can survive crashes, even of high-performance aircraft; (iii) is economical in both installation and maintenance.

**Basic Operation:** The Leigh Crash Position Indicator consists basically of an airfoil-encapsulated radio beacon and crash detection sensors that assure satisfactory deployment. The radio beacon is automatically actuated upon deployment and transmits immediately. Encapsulation of the radio beacon in the form of a tumbling airfoil ensures safe deployment of the equipment at a safe distance from the crash point. The trajectory of the airfoil approximates a circle of 100-foot (30.48 m) radius. The lift and drag characteristics are such as to guarantee safe deceleration to the terminal velocity of approximately 45 knots. In addition, the shock-absorbing qualities of the airfoil material completely protect the beacon from destruction in the event of a hard surface landing.

**The Radio Beacon:** Leigh solid-state pulsed beacons compatible with both SARAH air-sea rescue equipment and continuous-wave beacons are presently in use. The cw beacons are crystal controlled for the 121.5- or 243-megacycle distress bands, and are tone modulated by a sweeping audio signal. This technique of modulation makes the radiated signal easy to identify against the background of constant frequency interference which is always present in aircraft.

The existing Leigh radio beacons provide a signal detectable at distances exceeding 80 miles (128.7 km) when standard search equipment is used. In addition, the beacons operate for durations of approximately 48 hours and in ambient temperature ranges of  $-40^{\circ}$  to  $+132^{\circ}\text{F}$ . ( $-40^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$ ).

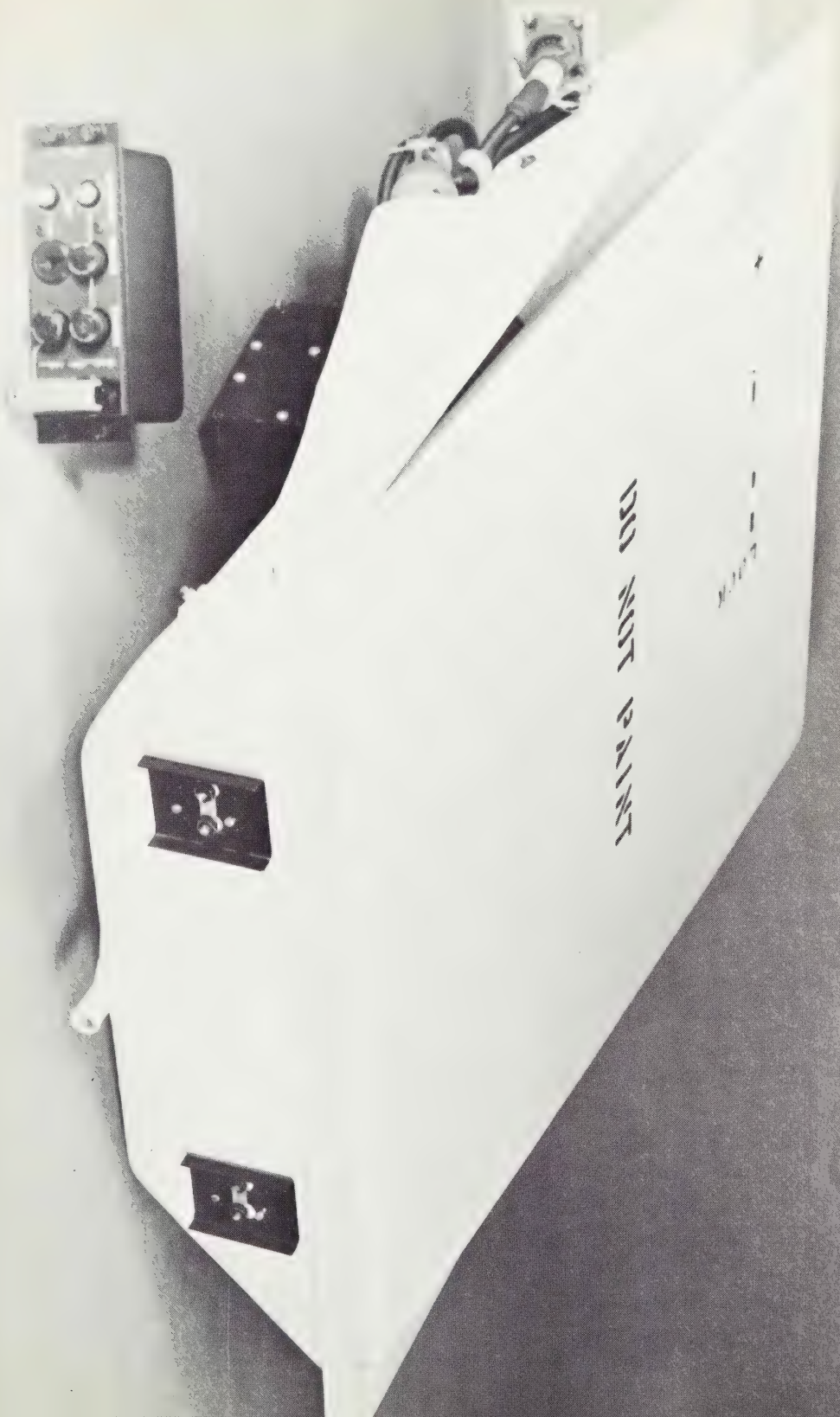
The antenna used in all beacons is a parallel plate type wholly enclosed in the airfoil. This configuration provides a radiation pattern particularly suited to the tumbling airfoil. The internal batteries of the beacon are nickel-cadmium types which are maintained at full charge by a low trickle current.

In 1962 the United States Air Force became interested in the Leigh Instruments Limited Crash Position Indicator System primarily because of the airfoil delivery system used to deploy the emergency distress frequency radio beacon from a crashing aircraft. Tests were Contracted for and conducted between July 1962 and October 1964 on various aircraft types (including the C135 and C133 aircraft). The equipment subsequently became USAF Inventory Item AN/URT 26(v).

It has been Contracted for and completely retrofitted to the C133 fleet, and is presently Contracted for and being fitted to the HC130H, C141, C124, C130 and C135 fleets. In all these fleet fitment cases, the airfoil is required to have Crash Data Recorder space and weight provision, i.e. the airfoil is capable of being retrofitted with a recorder tape cassette by simply inserting the cassette after removing the present dummy cassette.

ITEM	TYPE OF OPERATION CW
Frequency .....	Any frequency in 121.5- or 243.0- megacycle distress band, crystal controlled.
Modulation .....	Sweeping audio 300 to 1000 cps, repetition rate 2 per second.
On/Off Cycle .....	On continuously
Radiation Pattern .....	Omnidirectional
Typical Ranges* .....	50 nautical miles
Transmitting Life .....	2 days
Temperature Range (limited by batteries) .....	$-40^{\circ}\text{F}$ to $+132^{\circ}\text{F}$ ( $-40^{\circ}\text{C}$ to $+55^{\circ}\text{C}$ )
Altitude .....	Up to 50,000 feet (15,240m)
Weight (system) .....	17 pounds (7.7 kg.) (typical)
Dimensions (beacon only) .....	20 x 20 x 4 inches (50.8 x 50.8 x 10.16 cm) approximately

\* Detection range is limited by (a) terrain at beacon site, (b) efficiency of search receiver, (c) altitude of search aircraft.



## GENERAL PURPOSE DOPPLER SENSOR

Canadian Marconi Company-designed doppler sensors, employing the then novel FM/CW modulation technique, were being evaluated by military and commercial operators as early as 1956/57. Designated the CMA-620 series for the commercial application, the AN/APN-501 and AN/APN-147 became the military versions of this highly successful series. More than 3500 such sensors and developments thereof are flying in a variety of aircraft throughout the world.

Today more than 13 years of experience in evolutionary design, development and production are embodied in the CMA-650 series of truly 'General Purpose Doppler Sensors' now in production. The CMA-650 series general purpose doppler concept basically comprises a doppler sensor capable of accurately operating in the flight regimes of rotary and fixed wing aircraft and the applications for which they are employed. At the same time, its built-in versatility allows the user to choose only those performance characteristics of the sensor required for his application(s). Considered modular design makes this a question of merely sliding-in or taking-out the relevant modules; e.g., a fixed wing conventional or STOL aircraft does not require a sensor with hover capability whereas from an interchangeability point of view this capability can be immediately restored by plugging in the hover modules. It need not be stressed that considerable savings and simplifications can be achieved by exploiting this concept in the maintenance and operation of a mixed fleet of doppler equipped air vehicles. This concept has been adopted in the widely used military sensors AN/APN-168 and AN/APN-503(V). Still greater versatility is built into these sensors by the provision of an optional module that gives the sensor an accurate low-level radar altimeter capability.

Evaluations in helicopter and STOL aircraft of the Canadian and US forces have been proven highly successful and the equipment has been in quantity production for some time.

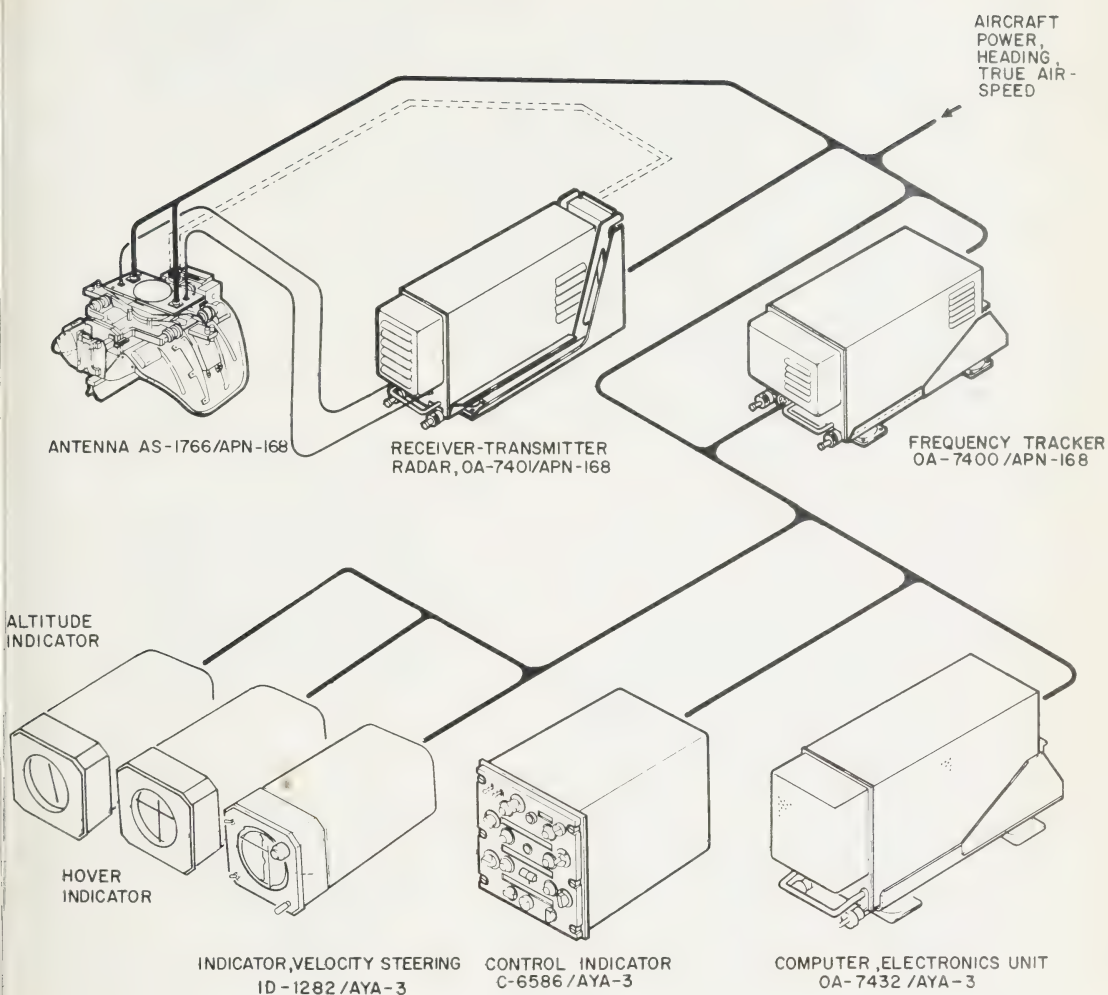
The Sensor and computer use the same controller and both Doppler and Computer information are displayed on the same three inch instrument. The hover and altitude indicators may be included or omitted as requirements dictate.

Another point that warrants attention is the fact that CMC has been able to retain the simplicity and superior operational accuracy typical for a design using the FM/CW technique with track stabilized antenna. Although at first sight this may look to be a bit of an anomaly in the case of a hovering aircraft, CMC has found an extremely effective solution to this problem by allowing the antenna to move freely in drift during hover whilst simultaneously carrying out a direct high speed measurement of  $V_h$ ,  $V_d$  and  $V_r$  using the antenna drift position for the necessary coordinate orientation. These high speed outputs are used exclusively for ASE inputs and hover indications.

Thus, whilst retaining the high accuracy speed and drift outputs of the track stabilized antenna for the navigation application the hover condition is taken care of by accuracies measured in fractions of knots rather than percentage, thereby solving the requirements for both conditions in proper perspective.

*(Please see page I-46 for the complementary Computer)*





## MICROMINIATURIZED DOPPLER SENSORS

The proven features of the Canadian Marconi Company general purpose Doppler Sensor, which is described on page I-40, have been combined with the latest advances in electronics techniques and components in a third generation of helicopter Doppler sensors represented by the AN/APN-172 and AN/APN-173. The two sensors are similar except that the AN/APN-172 is designed to interface with a digital computer while the AN/APN-173 is designed to interface with an analog computer.

Wide use of micro-electronics and the use of a completely solid state microwave source have resulted in large weight savings and improved reliability. The weight of the AN/APN-172 is only 36 pounds (16.3 kg) and that of the AN/APN-173, including all of the units shown on page 000 is 42.8 pounds (19.4 kg). The calculated Mean Time Between Failures for the two systems is in excess of 1200 hours.

Each sensor contains two main units, a Receiver-Transmitter-Antenna and a Signal Data Converter. The Receiver-Transmitter-Antenna generates and transmits 150 mw of microwave energy at a frequency of 13,325 MHz. The reflected energy is processed and fed at an intermediate frequency to the second unit, the signal Data Converter where further processing yields outputs corresponding to aircraft velocity and altitude.

The performance of the AN/APN-172 and AN/APN-173 is automatically monitored by means of a tracker monitor, and a memory signal is generated immediately a usable Doppler signal is lost. In addition Built-In-Test-Equipment (BITE) continuously monitors the operation of every module in the system and if a fault develops the appropriate BITE indicator operates. A feature of these indicators is that they retain indication after the power is switched off so that the fault indication is available to maintenance personnel as an aid in rapid fault finding. The BITE module also contains circuitry for a "Test on Command" feature that can be initiated on the ground or in flight. During this test proper operation of the navigation set is indicated by the ground speed and drift angle going to pre-determined values.

The altimeter portion of these sensors uses the carrier dispersion principle used in previous CMC Dopplers and in the CMA-521 Radar Altimeter which is described on page 000. It permits measurement of aircraft height above terrain with an accuracy of  $\pm 2$  feet (.6 cm)  $\pm 2\%$  over the range of 2 to 3000 feet (.6 to 914.4 m). The validity of the altimeter output is continuously monitored using the lock-check principle.

The AN/APN-172 provides the following outputs:

OUTPUT	FORM	RANGE	SCALE FACTOR
<i>Heading Velocity</i>	Digital	-50 to +250 k	0.140 k/bit
	Analog DCV	-50 to +50 k	5 microamps/knot
<i>Drift Velocity</i>	Digital	-100 to +100 k	0.140 k/bit
	Analog DCV	-50 to +50 k	5 microamps/knot
<i>Vertical Velocity</i>	Digital	$\pm 5000$ ft/min	4.9 ft/min/bit
	Analog DCV	$\pm 5000$ ft/min	0.2 microamps/ft/min
<i>Altitude</i>	Digital	2 to 3000 ft	1.40 ft/bit
	Analog DCV	2 to 3000 ft	3 millivolts/ft

The AN/APN-173 provides the following outputs:

ELECTRICAL			
OUTPUT	FORM	RANGE	SCALE FACTOR
<i>Groundspeed</i>	Pulse Train	-50 to +250 k	As required
<i>Heading Velocity</i>	400 Hz voltage	-50 to +250 k	30 mvrms/k
<i>Drift Velocity</i>	400 Hz voltage	-100 to +100 k	30 mvrms/k
<i>Vertical Velocity</i>	400 Hz voltage	$\pm 5000$ ft/min	1.5 mvrms/ft/min

VISUAL			
OUTPUT	TYPE OF DISPLAY	RANGE	RESOLUTION
<i>Groundspeed</i>	Counter	-50 to +250 k	1 knot
<i>Drift Angle</i>	Pointer & Dial	180° left to 180° right	1°
<i>Altitude</i>	Pointer & Dial	2 to 2500 ft	5 ft
<i>Heading Velocity</i>	Horizontal & Vertical Bars	$\pm 40$ k	2 k
<i>Drift Velocity</i>			
<i>Vertical Velocity</i>	Pointer & Linear Scale	$\pm 1000$ ft/min	50 ft/min





## SUPERSONIC DOPPLER SENSORS

Canadian Marconi Company's latest third generation Dopplers are the CMA-668 family of sensors designed specifically for supersonic aircraft. These Dopplers are characterized by:

- (a) Low weight and volume
- (b) High accuracy and reliability
- (c) Inertial compatibility
- (d) Built-In-Test Equipment
- (e) Ease of field maintenance
- (f) Integral altimetry.

The light weight (34 lbs) CMA-668, like all Canadian Marconi's third generation Dopplers is completely solid state, extensively utilizes microelectronics, and uses the beam intersection technique to obviate sea bias errors. The CMA-668 is also representative of previous generations of CMC Dopplers, featuring FM/CW modulation, track-stabilized antenna, and the Carrier Dispersal altimeter technique; these features have become trade marks of all CMC Dopplers. Other attributes incorporated in this supersonic Doppler sensor are automatic acquisition over the entire groundspeed range, a continuous data validity check, an operator initiated system self test and Built-In-Test Equipment (BITE). This combination of self test and BITE permits a failure to be detected and isolated to the line replaceable unit (LRU) without the aid of test equipment. Further fault isolation down to the module level is accomplished with this self contained test capabilities in conjunction with standard test equipment. Since the CMA-668 is of modular construction a faulty module can be quickly detected and replaced, and the system verified for service. This ease of maintenance combined with the inherent high reliability of the CMA-668 dictates a minimal cost of ownership.

The CMA-668 family of Doppler sensors is designed to operate at horizontal and vertical speeds of Mach 2.9 and Mach 1.8 respectively at altitudes up to 65,000 feet (19,812 m). Integral altimetry is available which will measure altitude up to 30,000 feet (9,144 m) with an accuracy in the order of 2%. The highly accurate outputs (0.1% for groundspeed, 0.1° for drift angle), which can be encoded for use in digital computers, have been optimized to provide Doppler Inertial system compatibility. Salient features of these new supersonic Dopplers are listed below:

### PERFORMANCE DATA

<i>Temperature Range</i>	-65° to +160°F. (-53.8° to 71°C)
<i>Sensor Range</i>	50 - 65,000 ft. (15.2 to 19,812m)
<i>Automatic Acquisition</i>	Within 10 seconds
<i>Reflectivity</i>	All terrain and sea states down to Beaufort 1. Automatic compensation for sea bias.
<i>MTBF</i>	1000 hrs.

### ANTENNA STABILIZATION

<i>Gimbal Limits</i>	Pitch +20° to -15°
	Roll ±35°
	Drift 20° right or left
<i>Attitude Rate</i>	Pitch ±20°/sec
	Roll ±40°/sec
	Drift ±20°/sec

### SYSTEM ELECTRICAL CHARACTERISTICS

<i>Input Power</i>	115 V AC 1 $\pi$ 400 Hz
	150 VA max.
<i>Transmitter Output Power</i>	350 mW
<i>Transmitter Output Frequency</i>	13,325 ± 10 MHz
<i>Modulation</i>	FM/CW



## NAVIGATION COMPUTERS, AIRBORNE

Parallel with the development of doppler sensors Canadian Marconi Company has been engaged in the design and development of compatible navigation computers. Starting with the CMA-601 track guidance computer, in accordance with ARINC characteristic 543, and used with the CMA-620 series doppler sensors in the commercial transport application, designs have branched off into various other commercial and military applications; e.g., the AN/ASN-35 track guidance computer is a more sophisticated version used in military transport aircraft. In total numbers, computers almost equal the number of doppler sensors in use.

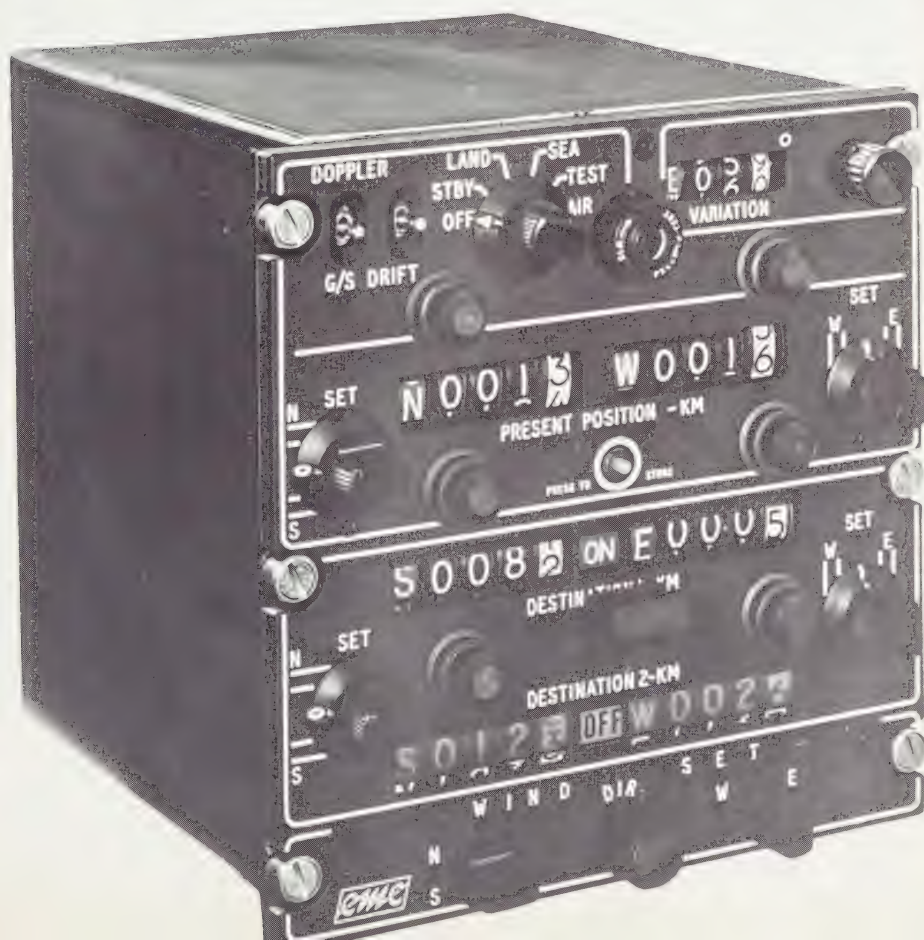
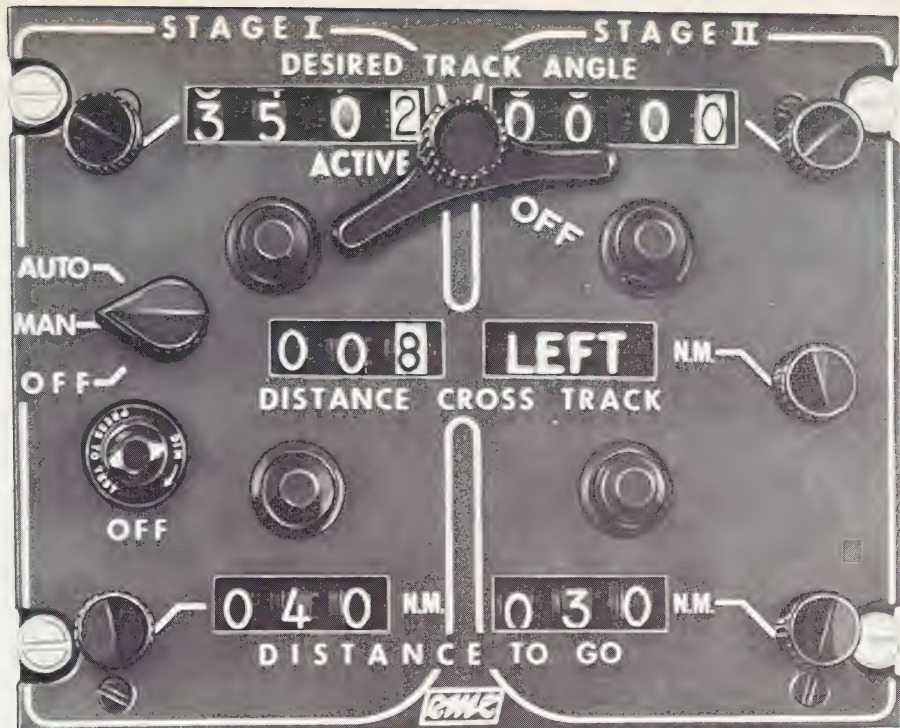
In addition to being extremely reliable, one of the more salient features of these computers is the operational digital technique basic to their design. This technique takes full advantage of the high accuracy digital groundspeed outputs available from CMC's doppler sensors. It has also resulted in the availability of a lat/long computer (CMA-690-AN/ASN-35A) yielding outputs of similar accuracy up to and beyond 89 degrees of latitude. Computer outputs can be integrated with digital and pictorial displays, autopilots and the like.

Another distinctive development is the AN/AYA-3 two destination computer (with option of up to 12 destination memory), which computes and displays present position in terms of rectangular coordinates relative to an arbitrarily selected reference point. A pictorial display of bearing and distance to the selected target is part of the system, whilst wind speed and direction are continuously computed and memorized, and may be displayed at will.

The AN/AYA-3 Navigation Computer and the AN/APN-168 Doppler sensor together make up the AN/ASN-64 Doppler Navigation Set which has found wide application in a variety of helicopters and fixed wing aircraft. In order to meet the requirements of different customers versions of the AN/AYA-3 with calibrations in kilometers, nautical miles and in Universal Transverse Mercator Grid or latitude and longitude coordinates are available.

*(Please see page I-42 for the complementary microminiaturized Doppler Sensor)*





## AUTOMATIC PERMANENT MAGNETIC COMPENSATOR (APMC)

The APMC was developed and designed by the Electronics Division of CAE Industries Ltd. to improve Magnetic Anomaly Detection (MAD) performance of ASW aircraft. Production quantities have been manufactured and delivered to Canadian Forces and the equipment is in service in Canadian Argus (CL-28), Neptune (P2V), and Tracker (CS2F-2) ASW aircraft. The APMC has been fully qualified and satisfies all of the requirements of RCAF Specification RAD-1-18.

The latest version of the APMC is fully transistorized and has been designed to meet USN Specification MIL-C-81328(WP). USN will procure this equipment for their P2V fleet and on this basis a major production program will be launched at CAE before March 31, 1967. Other orders will be received from the Royal Australian Air Force for their Neptunes and from the Royal Australian and Royal Netherlands Navies for their Trackers.

The advantages and improved MAD performance which are possible with the APMC are indicated in the following notes:

1. The APMC is used with AN/ASQ-8 or AN/ASQ-10 MAD equipment and provides improved MAD performance by the optimum elimination, or compensation, of permanent magnetic field interference generated by the aircraft.
2. The APMC replaces "Magnetic Compensator" CN-191/ASQ-8 which is used with the AN/ASQ-8 and AN/ASQ-10 for manual permanent field compensation. The CN-191/ASQ-8 provides for the manual adjustment of current through 3 mutually perpendicular coils located near the MAD detecting head, so as to generate an equal and opposite magnetic field to that produced by the aircraft. Cancellation of the permanent magnetic interference from the aircraft is thus achieved. The APMC does this automatically, decreases the time required to compensate by approximately 80% and achieves much improved compensation.
3. Improved compensation results in improved detecting ranges since the elimination of aircraft interference allows for identification of submarine signals down to the basic sensitivity of the AN/ASQ-8 and the AN/ASQ-10.
4. Present practice in the RCAF and the RCN is to re-compensate 4 times per year, since the aircraft's magnetic field changes with time. These compensation flights, using manual techniques with the CN-191/ASQ-8, last approximately 3 hours each and consist of flying the aircraft on cardinal headings while doing 10° rolls and 5° pitches. The operator must plot a graph of compensator settings vs. MAD manoeuvre signals in order to determine the best setting. These sustained manoeuvres can lessen the efficiency of the operator resulting in poor compensation.
5. With the APMC the operator merely has to actuate the equipment and the compensation is achieved automatically. No plotting of data is required and compensation time is reduced by at least 80%. Optimum compensation is assured which results in maximum detection range.
6. It is noted that 3 hours per compensation flight 4 times per year represents considerable flying time. Accordingly, a considerable saving can be realized by use of the APMC. Also, manual compensation requires extended manoeuvring over a magnetically quiet area, usually at 10,000 ft. (3048 m) altitude. The APMC can be used at operational altitudes over almost any area. Since an aircraft's permanent magnetic field changes with time, the APMC allows for convenient and rapid recompensation, so that maximum MAD range is assured at all times.
7. The APMC is the same size and exactly fits into the space now occupied by the CN-191/ASQ-8. Installation is quick and convenient and cabling additions are minor.



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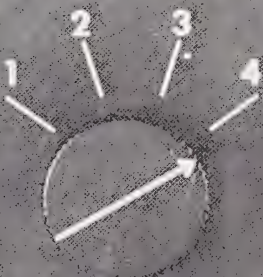
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## THE 9-TERM COMPENSATOR (9-TC)

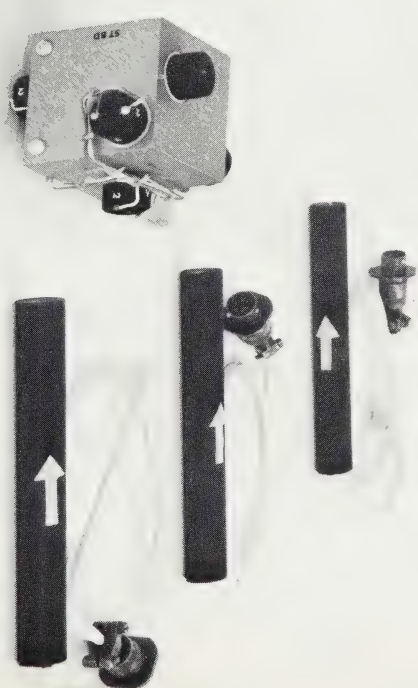
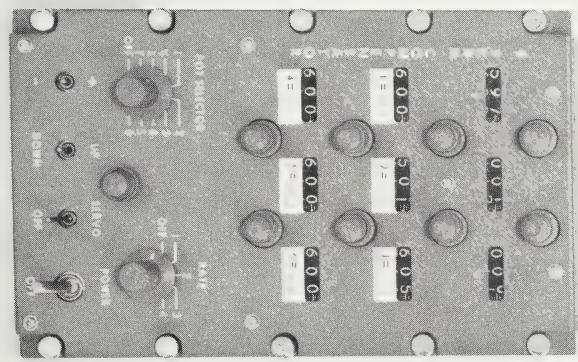
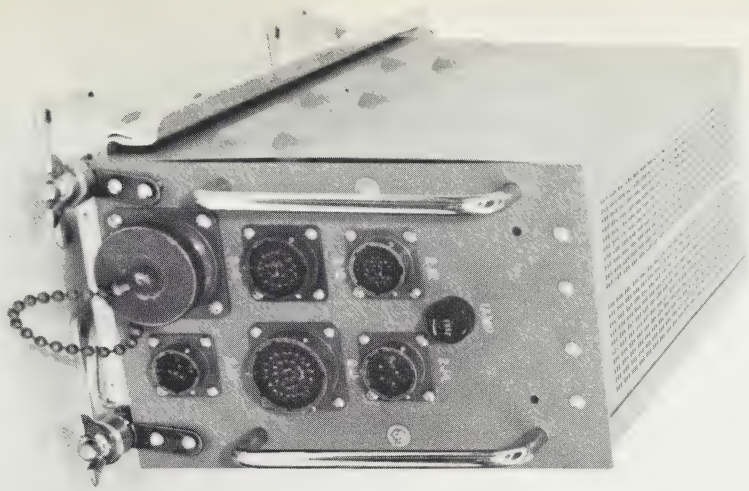
The APMC was developed to compensate for interference generated by an aircraft's permanent magnetic field. There are two other sources of magnetic interference which require compensation on MAD equipped aircraft. Induced fields are caused by the ferromagnetic materials of an aircraft being magnetized as the aircraft moves through the earth's magnetic field and eddy-current fields are caused by currents created in control surfaces and fuselage as the aircraft moves through the earth's field. The 9-TC is an advanced compensator which was developed by CAE to eliminate interference from all permanent, induced and eddy-current field sources.

Before the development of the 9-TC, induced and eddy-current field were compensated for by the design of fixed permalloy strip configurations mounted near the MAD detector and by fixed coils also installed close to the detector. The strips and coils were designed to create equal and opposite induced and eddy-current fields to those generated by the aircraft. These fixed compensators require custom design for each aircraft type, involving lengthy experimental flying, and do not cater for changes in induced and eddy-current sources during the life of the aircraft. Also, they require close tolerance hardware to be installed close to the MAD detector, normally in the non-magnetic (fiberglass) MAD boom and they do not provide adequate compensation for next-generation more sensitive MAD.

The 9-TC has the following advantages:

1. Provides semi-automatic electronic compensation for all aircraft generated permanent, induced and eddy-current field interference.
2. Fully solid-state and qualified to USN Specification NAVAIRDEVCON AW 3338.
3. Compatible with present and future more sensitive MAD.
4. Short "trim-up" procedures enables optimum compensation for all interfering sources to be achieved at all times.
5. Applicable to new ASW aircraft without lengthy, expensive flight time.

The 9-TC is in production for the newest RAF ASW aircraft, the HS-801 and deliveries to Hawker Siddeley have started in January 1967. The 9-TC has been adopted by USN for use in the "A-New" Orion (P3C). The prototype has been delivered for this program and production quantities being ordered.



## REGISTERING 'G' METER

One of the major problems confronting aircraft operators has been the maintenance of airframes. An overhaul schedule based on number of flying hours or calendar time limits proved unsatisfactory since the structural condition of identical types of aircraft, on similar duties, differed considerably due to the fact that aircraft are subject to various G-loadings depending upon many contributing factors. Investigation indicates that the G-loadings are a major factor in airframe wear and fatigue.

The Aviation Electric Registering 'G' Meter is designed to sense the magnitude and count the applications of 'G' loadings along the vertical axis of an aircraft. The sensor design is such that up to 23 increments of 'G' within a maximum range of  $-2.5\text{ G}$  to  $+9\text{ G}$  can be sensed and transmitted electrically to panel or remotely installed registers. Each indicator contains four 4 figure digital counters and multiple indicators can be installed to provide readings for all of the 'G' increments or a selection suitable for the type of aircraft in which the system is installed.

### Applications

1. To record flight loads along the aircraft vertical axis at, or near, the aircraft CG.
2. To record G loadings along the aircraft vertical plane at points other than the CG.
3. By suitable switching (oleo leg extension switch) landing and taxi loads can be recorded on separate counters, eliminated or included in the overall recordings.
4. By alternative orientation the system can measure and record accelerations during catapult launch, rocket launch or arrested landings.
5. By recording G loads applied to an airframe and the total count of such loads, the Registering 'G' Meter will assist airframe manufacturers and aircraft operators in determining statistically the safe fatigue life of an airframe.

### System Features

1. Hermetically sealed miniature sensor with provision for mounting on horizontal or vertical surfaces.
2. Clamp or bezel mounted register for panel or buried installation.
3. Range (within limits of sensor), selection of check points, and reset point can be varied by external cable changes only. If more than four recordings are required additional registers can be used.
4. Reset circuit prevents erroneous counts caused by small local vibrations at any G increment.
5. Magnetic damping employed in sensor to provide a constant damping factor over the temperature range.
6. Sensor and Register hermetically sealed to ensure satisfactory operation at all altitudes.
7. Temperature range of components  $-65$  to  $+250^{\circ}\text{F}$ . ( $-18^{\circ}\text{C}$  to  $+121^{\circ}\text{C}$ )

### Operation

'G' loads at the sensor position are sensed by a mass weight located between vertical guides. G forces displacing the mass are balanced by a clocktype spring whilst rate of displacement is controlled to give optimum performance by magnetic damping. Mass displacements are transmitted mechanically to a wiper arm operating over a commutator. Contact of the wiper arm with each successive segment of the commutator applies a 28 volt DC supply to an electro-mechanical counter and causes it to register 1 digit. The counters are of a self-locking type and the circuit is arranged so that the counter locks after moving 1 digit. No further recording is made until the 'G' force has reduced to a pre-set threshold value, thus preventing small local vibrations from falsely producing a high number of erroneous counts at any 'G' increment.





## AERIAL RECONNAISSANCE SYSTEMS

Designed and produced by Computing Devices of Canada Limited, in cooperation with W. Vinten Ltd. of England, this photographic reconnaissance equipment combines the attributes of the famous Vinten 70mm camera with Computing Devices' established knowledge in the data handling and control system field. This system, designed for versatility, provides at low cost, optimum reconnaissance intelligence from any type of airborne vehicle.

### Features

- *System*—rugged and simple, hence reliable and inexpensive to buy and maintain.
- *Camera*—a 70mm camera in service throughout the world . . . a camera of proven performance and established reliability for both day and night operation.
- *Auto-Exposure Control*—a simple three stage system completely automatic . . . using solid-state switching techniques.
- *Data Recording*—readable directly in alpha-numeric form from the 70mm negative . . . standard unit provides three sets of three-digit counters to display target position or other data.
- *Remote Control*—no direct power controls from cockpit to photo system . . . small console provides operator with indicators and selection controls . . . cameras are triggered by a push-button on the pilot's control column.

Management capability in photo-reconnaissance systems has been well established on the CF-104 Photo Pod Program. The PR 3-2(4) system was designed to operate on information received from the existing CF-104 navigation system, and was integrated mechanically and electrically into the pod which was designed simultaneously. All units and the complete system were then tested in accordance with Royal Canadian Air Force Specifications. Computing Devices are responsible for the manufacture of the PR system, and assembly and checkout of the complete pod package. Courses for service trainees have been held at the plant, and training aids that simulate the PR system and pod have been delivered to the RCAF. Ground support equipments consisting of a Unit Test Set and a System Test Set have also been designed, produced, and delivered to the RCAF.

In addition, the firm has produced manuals on each equipment, including training and support equipment, and will produce the official RCAF Engineering Orders for the system. Field representatives are available throughout the world during all phases of any program.





## CMA-521 RADAR ALTIMETER

Canadian Marconi's CMA-521, an accurate Radar Altimeter designed for installation in any rotary or fixed wing aircraft, measures precise altitudes from -20 to 2500 feet (6.1 to 762 m). The CMA-521 utilizes the Carrier Dispersal height measurement technique invented and originally used at CMC for altimeter attachments to Doppler sensors.

The Carrier Dispersal technique, a new and most effective approach to the actual height measurement problem, is a genuine advancement in the altimetry art. The technique basically consists of finding the amount of frequency modulation required on the transmitter in order to disperse a fixed fraction of the power from the received carrier. This process does not display any of the disadvantages or ambiguities inherent in the Pulse, Swept FM/CW, and Bessel Mode FM/CW techniques, such as, step, offset, and Doppler errors; spatial insensitivity, noise; poor resolution; false locks; interference nulls; microphonics; poor performance in rain; and relatively large bandwidth and power consumptions. The CMA-521 displays none of these faults and uses such a small portion of the bandwidth allotted for Radar Altimeters that dual simultaneous operation, as required for category III approaches, can be realized without any interconnections or RF interference between the two systems.

The CMA-521 Radar Altimeter, consisting of two fixed antennas, a receiver-transmitter unit and an indicator, is designed to meet or exceed the requirements of ARINC characteristic 552. The all solid state construction plus the extensive use of microelectronics in several circuit functions ensures high reliability. This high reliability combined with the modular construction and Built-in-Test Equipment (BITE) of the CMA-521, minimizes maintenance cost and time while completely eliminating the necessity for first line test equipment.

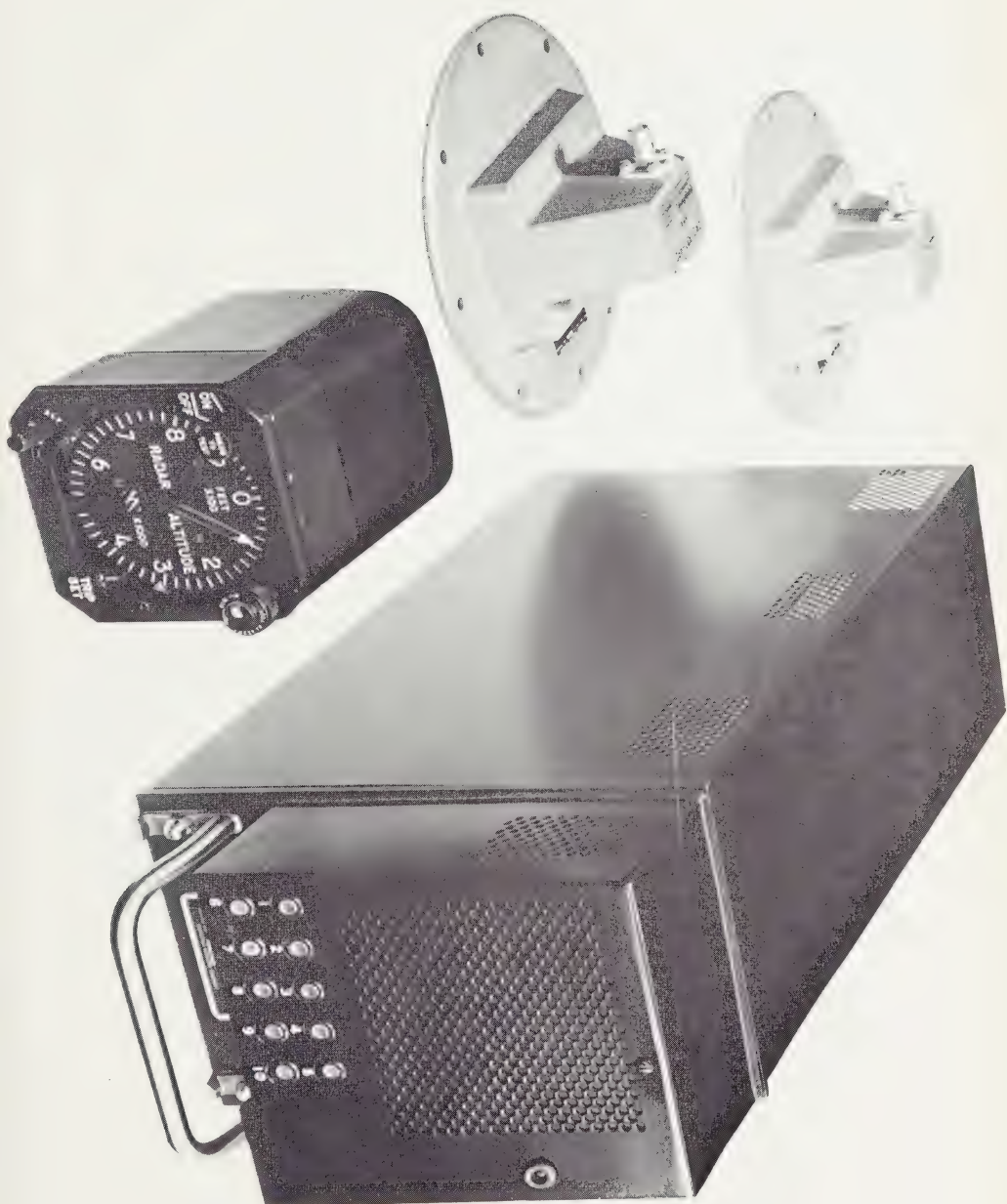
The Built-In-Test facilities in the CMA-521 Radar Altimeter provide the operator, while airborne or on the ground, with GO/NO-GO readiness indications. The readiness status of the CMA-521 is continuously defined by the monitoring of ten BITE sensors. This BITE information is displayed on fault indicators mounted on the front of the Receiver-Transmitter Unit. A self-test mode of operation is also provided to allow the performance of a confidence check on the complete Radar Altimeter. This end-to-end test can be initiated by pressing the "ON-OFF" switch which simulates a given value of altitude at the receiver. A high level confidence check is verified by the display of the prescribed value on the indicator. Self-check features also continuously monitor signal lock-on, tracking and output accuracy.

The CMA-521 provides two linear outputs of both altitude and altitude rate with accuracies of 1 ft. (30.48 cm)  $\pm$  20% and 20 ft/min. (6.1m/min)  $\pm$  8%, respectively, at low altitudes. Altitude limits are  $\pm$  30° in roll and  $\pm$  25° in pitch.

A maximum of six pre-set, shop-adjustable trips, covering the entire altitude range, provide altitude signals to ancillary equipments. A single pilot-adjustable trip, adjustable in flight over the entire altitude range, is controlled by the altitude set knob. A warning light on the face of the indicator is illuminated when the measured altitude is less than the set altitude.

The CMA-521 Radar Altimeter, weighing less than 20 pounds (9.1 kg), displays the following major electrical characteristics:

<i>Frequency:</i>	4300 HMz nominal, crystal controlled
<i>RF Output:</i>	500 MW nominal
<i>Modulation:</i>	Carrier Dispersal FM/CW
<i>Modulation Freq:</i>	10 KHz and 160 KHz
<i>Bandwidth:</i>	16 Mc Max.
<i>Power Input:</i>	115V 400 Hz single phase, 100 VA



## SERVO REPEATER AMPLIFIER

The Leigh Servo Repeater Amplifier is designed to meet the need for an accurate, reliable and compact servo retransmission from a low power synchro source to a number of isolated high power torque receivers or control transformers.

The unit consists of a repeat servo using a high impedance control transformer and a unique transistor amplifier. The servo drives up to six size 11 high-power synchro transmitters, all of which can be separately excited, and can, in turn, drive up to 24 high torque synchro receivers.

- Rugged construction — can be either shock mounted or mounted directly to aircraft structure.
- Rubber gasketed for effective dust sealing
- Uses all stainless steel Leigh gearhead
- MIL approved parts used throughout
- Meets design requirements of MIL-E/5400, Class II equipment.

Complete qualification testing has been performed to MIL-E/5272, including vibration, shock, temperature 0-54 C to -71 C, sand and dust, rain, salt spray, humidity and radio interference.

Compatible with C-2, J-2, N-1 gyros, and can drive indicators such as DRMI-1D416, MN97H and AN/ARN501 Tacan. Can also be used for multiple bearing and heading displays for navigation systems and other repeater applications.

### SPECIFICATION (Standard Unit)

<i>Input CT impedance</i>	Zro 800 + j2900 Zso 115 + j470 Zrss 890 + j350	Optional—2 extra size 11 transmitters and 1 size 10 standard or clutched synchro.
<i>Follow Up Rate</i>	30 degrees/sec.	Overall Accuracy ±20 minutes maximum under all conditions.
<i>Optional</i>	60 degrees/sec.	
<i>Outputs</i>	4 size 11 torque transmitters	Power (not including synchro excitations) 26V 400 cps 10VA Optional 115V 400 cps
<i>Stator voltage</i>	11.8V	
<i>Output unit torque gradient</i>	5700 mg.mm/deg.	Weight (less mounting tray) 2.3 lbs. (1.04 kg.) Weight (mounting tray only) 0.5 lb. (.226 kg.)





## SERVOED ALTITUDE INDICATORS

The presentation of aircraft altitude information using the traditional multiple pointer against a fixed circular scale is a definite aviation safety hazard. The multiple-pointer indicator requires that the pilot (i) carefully observes the pointers, (ii) reads the values indicated, and (iii) makes a mental summation. This technique is hazardous because the time required to perform these tasks is long and the necessity of making the mental summation opens the door to error.

Critical examination of altitude display techniques by the RCAF Institute of Aviation Medicine (IAM) has revealed that the common summation errors are in thousands and even ten thousands of feet.

The Leigh Servoed Altitude Indicator displays altitude by two distinct and unambiguous methods: i) a fixed-figure, four-drum digital readout and ii) an outer dial, single-pointer display. The dial-pointer scale is linear and repeatable every 1000 feet.

An optional command altitude marker, incorporated in the display, simplifies the task of maintaining a pre-selected altitude. The command altitude marker is optional and may be operated manually by a second setting knob or remotely by a separate slewing control.

### FEATURES

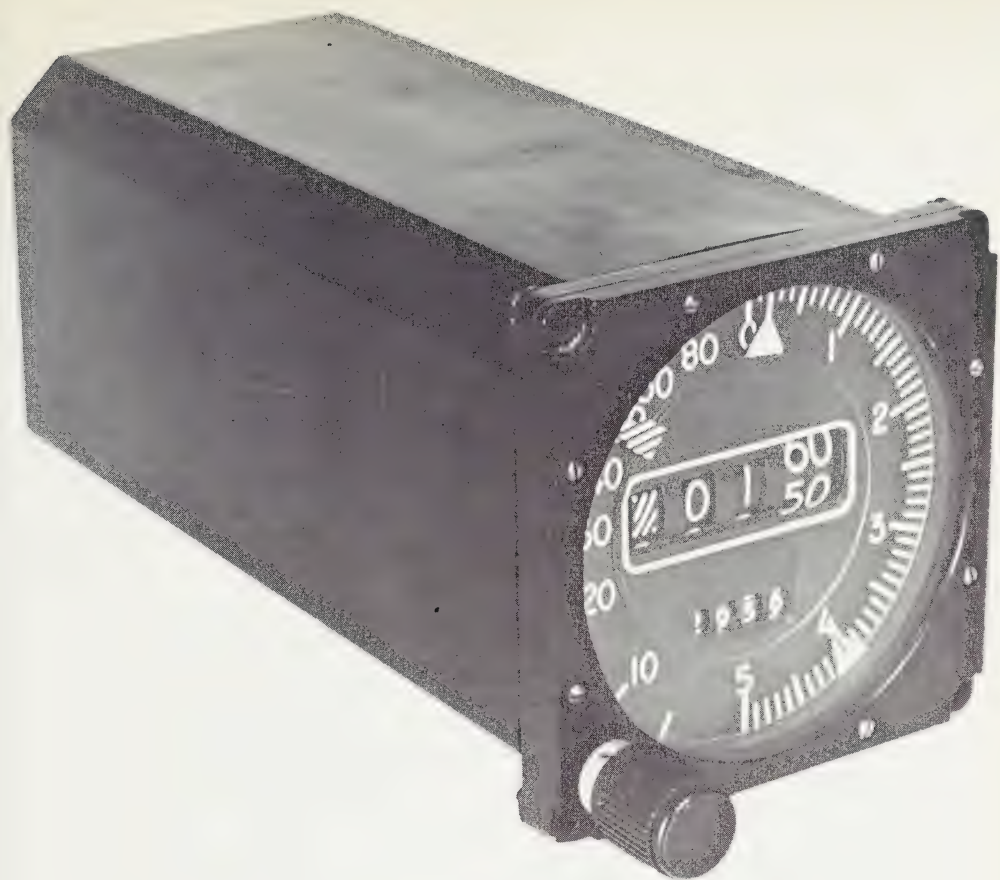
- Accepts inputs either from commercial or military altitude computers
- Reduced pilot error and shorter reading time
- Direct, single reading, eliminating the necessity for mental summation
- 0 to 99,980 feet (0-30,474 m) presented on five-digit counter
- 0 to 1000 feet (0-304.8 m) displayed on linear dial-pointer display repeatable every 1000 feet (304.8 m).
- Failure warning system actuated by excessive error or power failure
- Command altitude marker aids in maintaining selected altitudes (optional)
- Flight recorder output
- Barometric pressure compensation displayed on four-digit counter
- Red-and-white double wedge lighting conforms to MIL-L-25467B
- Proven circuit design with fail-safe dual-channel circuitry
- Conforms to ARINC Specification 545

## INTERVALOMETERS

Designed to trigger Sonobuoy drops to achieve a high degree of spacing accuracy between buoys. Intervals of 350, 700, 1050, & 1400 feet (106.7, 213.4, 320 & 426.7m) can be selected, with aircraft ground speeds of 100 to 200 knots. The first drop pulse is initiated by the operator, the second pulse, on the same wire, is provided by the intervalometer at the precise instant calculated within the unit. This equipment was designed and developed by Leigh Instruments Ltd.

### FEATURES

- Doppler or Manual groundspeed selection
- Self Test functions provided
- Solid State switching—no relays
- Illuminated panel
- Safe: a drop pulse can only be initiated from an external trigger source, not from controls on the unit itself
- Accurate — tolerance of  $\pm 14$  feet (4.3m) between buoys at any speed or interval setting.





## **AFDS-2 (AIRBORNE INFRA-RED FIRE DETECTION SYSTEM)**

The ability of infra-red devices to detect very small sources of "heat" radiation has been exploited for many years in specific fields. Only recently, however, has the technique been applied to the detection from the air of smokeless incipient forest fires, located under light to heavy foliage, day or night. Further use of the same equipment has been found in the mapping of going fires, even though smoke-obscured, for the determination of rate and direction of spread. Similarly, latent hot spots can be mapped from the air to hasten post-fire mop-up operations.

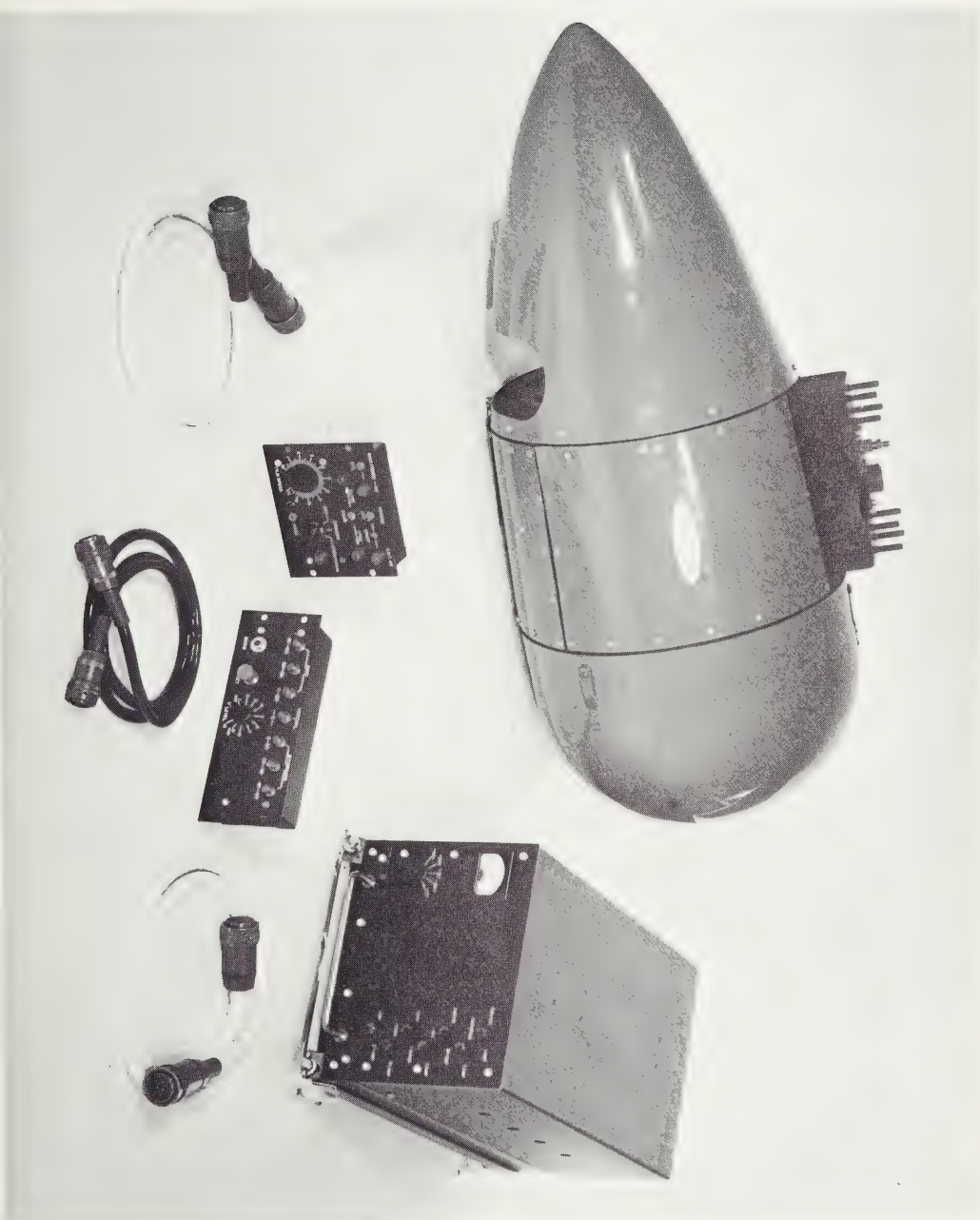
Computing Devices, over the past several years, has conducted a successful program to develop this airborne infra-red scanning system expressly for application by Forest Protection Organizations. The sound basic design philosophies, acquired by Computing Devices through past development, manufacture and installation of electro-mechanical equipment on more than 4000 aircraft throughout the world, have been applied to AFDS-2, to provide reliability and broad flexibility, along with simplicity of operation and maintenance.

Initial flight trials were successfully carried out early in 1964 in cooperation with the Ontario Department of Lands and Forests. Since then, continuous Company development and flight test programs have been conducted leading to the AFDS-2 design.

Basically, the equipment receives aircraft generator power at the Power Supply Unit which furnishes all system electrical power, regulated and fused. A nitrogen supply provides the coolant necessary for high detector sensitivity. Coolant containers, controls and connections are all commercially available. Both these supplies may be remotely located within the aircraft. The complete system is operated at a selected operator/observer station, usually in the cock-pit. The Control Console contains all functions necessary for the airborne utilization of the system. Also installed at this station is an Audio Alarm and Visual Indicator. All control and output units are compact, lightweight, and conform to aircraft configurations. A Film Recorder may be adapted for internal or external mounting.

Infra-red energy is received from the terrain below the aircraft and is focussed on the Detector. The detector generates an output electronic signal directly proportional to the amount of IR energy applied or "heat scan". This signal is amplified and applied simultaneously to the various system outputs. In the film recorder, a pinpoint of light is scanned across a photographic film at the same rate as the terrain below the aircraft. Hence, an IR terrain image is permanently recorded.

Instantaneous information is provided at the operator/observer station by the Display Unit which gives indication of the relative ground area from which a representative forest fire signal was detected. Simultaneously an audio alarm is sounded to bring the indication to the attention of the pilot or observer. This data is then correlated with ground data to pinpoint the precise fire location.



## AUTOMATIC MASTER HEADING CONTROL

The Automatic Master Heading Control designed and produced by Leigh Instruments is a navigator's instrument which provides simultaneous displays of grid, magnetic and true aircraft heading at all times. Integral with this display are smaller displays of variation and grivation (grid variation).

Convergency and command azimuth are separately displayed on the True Heading Dial. The instrument enables continuous monitoring of the standby gyro.

The navigator may control the navigation system heading reference and update it as required. Using the AMHC, he may correct both main and standby gyros, select either as primary sensors, update convergency, variation or grivation.

Command azimuth bearing can be set in on a three digit counter.

The control function can be carried out without upsetting the pilot's magnetic heading reference.

The AMHC accepts inputs of grid heading, convergency and magnetic slaving. Its outputs are Magnetic Heading, Grid Heading, True Heading, Convergency and Relative Bearing.

Grid Heading is accepted from the standby gyro and Leigh Instruments' Compass Repeater Amplifier which is fed by the main gyro. This provides separate headings which are converted into Magnetic or True as required by the aircraft.

The AMHC enables the navigator to correct gyro heading without disturbing the pilot's magnetic reference by torquing variation equal and opposite to the grid correction for cases where the magnetic sensor is operating.

Convergency is accepted as an M transmission and retransmitted as a synchro signal.

### FEATURES

- Gives aircraft global heading capability.
- Simplifies Polar Navigation.
- Allows full pilot control of the magnetic reference and provides navigator control of the gyros.
- Enables primary heading system to be, either True, Magnetic or Grid, depending on conditions.
- Standby or Main Gyro can be selected as primary heading sensor.
- Provides continuous monitoring of secondary system.
- Provides immediate indication of the need for corrective action.
- Automatic, accurate initial alignment.
- Automatic and continuous variation computation and display.





## TACTICAL MOVING MAP DISPLAY

Computing Devices of Canada Limited, Ottawa, has developed a new navigation device which provides an important advance in the presentation of navigation information which has both civil and military aviation application.

The development of the Moving Map Display (Topo Map), which will be in production in 1967, included a three year period of extensive flight testing, including trials in the Royal Air Force, the French Army Light Aviation Group and the Royal Canadian Air Force.

Termed "the map that moves with the aircraft" the Moving Map Display provides the pilot with a continuous projection of the complete topographical or aeronautical detail surrounding the aircraft's present position.

The Topo Map was developed in particular to meet the requirements of the pilot of low-level, high speed aircraft who must be continuously aware of the relation between his current flight path and the surrounding and approaching terrain.

The maps required for any given area are photographed and placed on 35 mm film. These are projected on a brightly lit screen so that the aircraft's present position is in the center of the display. The pilot is thus able to see his position in relation to the topographic detail, increasing his effectiveness on a low-level mission. Map movement is fully automatic and the projection moves simultaneously with the aircraft.

The film magazine contains maps covering an area 1800 X 1800 nautical miles. In the original design by the Royal Aeronautical Establishment for the Ministry of Aviation, United Kingdom, the strip changes were made manually. However, company engineers redeveloped this concept and invented a method of doing this automatically. The maps used for the display are standard air navigation charts of any desired scale in full colour reproduction clearly visible under light conditions between bright daylight (10,000 ft. lamberts) and complete darkness. The high image resolution of the system permits easy recognition of symbols and lettering as small as 1/32 inch (.8 mm).

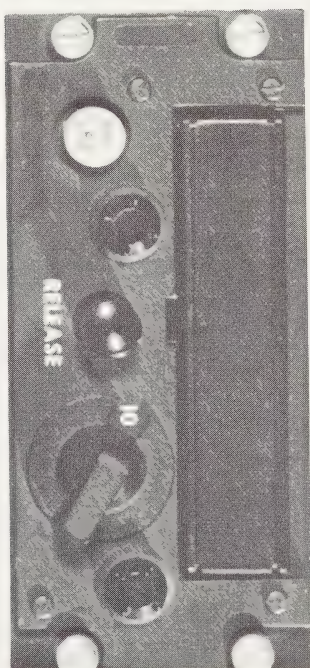
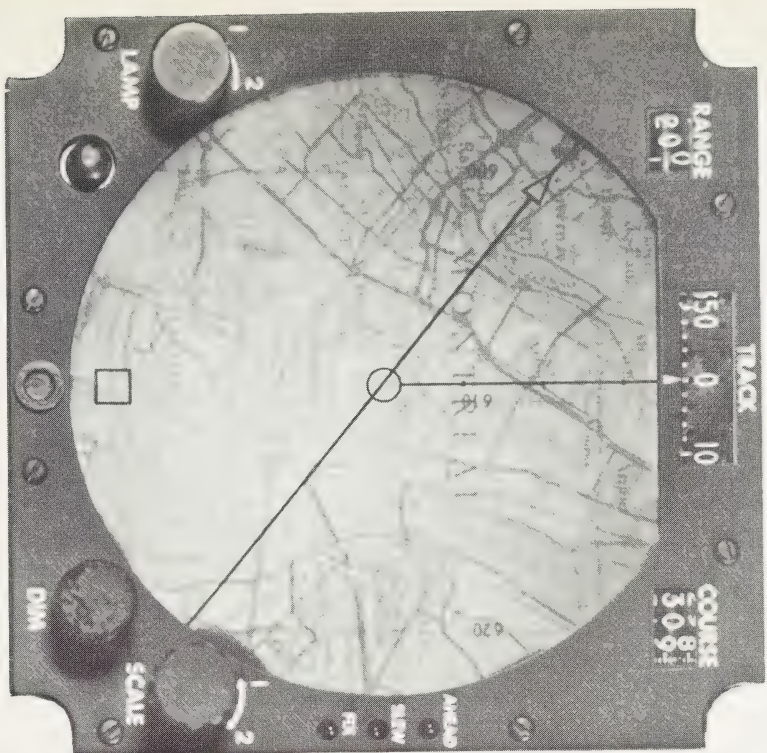
The display incorporates a look-ahead feature whereby the pilot may manually slew the map to display any area, or to store any destination. At command, the map returns to present position automatically. To overcome cockpit space limitations, course, track, track error and range to destination information are displayed on the same indicator.

The display can be interfaced with any navigation computer system, digital or analogue. Interface with Computing Devices' own computers, including the PHI-10B and UYK-501 have been developed simultaneously with the display and optimum navigation system packages. The display indicator measures 6x6x12 inches and weighs 13 lbs. (15.2 x 15.2 x 30.5 cm and 5.9 kg).

The Topo Map is another member of the family of airborne navigation equipments which Computing Devices have developed to meet the exacting demands of modern military aircraft.

*(For PHI-10B see Page I-70 & UYK-501 see Page I-124)*







## SPECTOCOM HEAD-UP DISPLAY SYSTEM

The Spectocom Head-Up Display System is a new approach to cockpit instrumentation developed initially by Specto Avionics Limited in conjunction with the Royal Aircraft Establishment at Farnborough, England. Subsequently, an agreement was entered into between Specto and Computing Devices of Canada for the expansion of sales and further joint development of Head-Up Display techniques.

This lightweight display system enables the pilot or weapons system operator of any type of operational aircraft to fly high-speed, low-level, all-weather missions with maximum concentration on his tactical task without compromising flight safety. Essential flight and operational information are projected into the pilot's line of sight, focussed at infinity so that any external obstacle, target or conflicting terrain is immediately perceived by the pilot. The display data can be varied by programming or by pilot selection and can include modes for take-off, enroute navigation, terrain-following, IFR station-keeping, approach, blind landing monitoring, or any one of several tactical armament modes.

The Head-Up Display System, an optical-electronic unit, comprises a Display Unit, a Control Box and a Symbol Generator.

The pilot's display unit incorporates a projection cathode-ray tube, collimating lens and reflector systems.

Symbols displayed can be viewed against a background light intensity of 10,000 foot Lamberts; in other words, against a background of bright sunlit clouds. For lower light levels there is automatic compensation.

The pilot's control unit includes the system on-off switch, the mode selector and a manual brightness control. This brightness control, once set by the pilot for the level he requires, is maintained automatically by a photo-electric device.

The symbol generator provides  $x$  and  $y$  deflection and bright-up waveforms to the cathode-ray tube. Information appropriate to the operational mode is contained in the bright-up waveform and is obtained by scanning a number of matrix stores. Should changes in the symbols displayed be required, they can be accomplished by modification to the matrix stores.

Maximum stability is obtained by a full exploitation of digital techniques to nullify the effect of transition parameters. Display Drift is  $\pm 2$  milliradians over a temperature range of  $-10^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  and  $\pm 4.5$  milliradians for  $-40^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ , without using excessive temperature compensation.

The flexibility of the basic Spectocom system makes it applicable to all types of aircraft, including helicopters. A typical configuration of the three units weighs approximately 30 lbs. (13.6 Kg), occupies 0.6 cubic feet (16,993 c.c.) and requires 40va of 115V, 400 cps power.

Intensive evaluation trials have been carried out by the Royal Air Force, Royal Canadian Air Force, Royal Canadian Navy, United States Navy and other operational organizations. These trials have shown that the unit contributes markedly to increased flight safety in all operating modes, permits safe operation to lower weather minima and reduces significantly the tendency towards premature touch-down in low-visibility conditions.

Systems produced by Specto Avionics and Computing Devices are presently flying in a variety of aircraft with the military services of several nations of the free world, including the RAF Hunter and P-1127 and the F-111B sweep-wing fighter-bomber in the United States.



## PHI — POSITION AND HOMING INDICATOR

The Position and Homing Indicator (PHI) was originally conceived as a point-to-point navigation system using the simplest possible computations with the most meaningful display of data to the pilot. Its simplicity, its capacity to store multiple destinations and its inherent reliability made it the popular choice of twelve nations for short range navigation. The PHI 3, 4 and 5, designed for interface with Doppler, Inertial or Air Data sensors, are still production items 15 years after conception and are still sound choices for aircraft with point-to-point navigation requirements.

The PHI 3, 4 and 5 systems accept input information from various sources or sensors such as air data, air data-doppler and air data-inertial equipments. Sensor changes are easily made by simply exchanging one or two modules in the computer. All PHI's can provide output to other aircraft systems such as photo-reconnaissance, automatic pilot, bombing computer, radar and the tactical moving map display (TMMD). The TMMD, developed by Computing Devices, provides the pilot with a continuously moving topographical map projection of the area over which he is flying, with his own position always indicated.

The PHI 3, 4 and 5 had the capacity for expansion which permitted the airborne programming of new destinations, for the output of information to other systems such as photo-reconnaissance, autopilot or radar and for the display of Tacan or ADF information, but for some roles this was not enough. In order to further expand capability without the sacrifice of basic simplicity a new series PHI-10B has been developed.

Although the number of units in the different systems varies, the basic elements of each are an indicator, a control console and a computer.

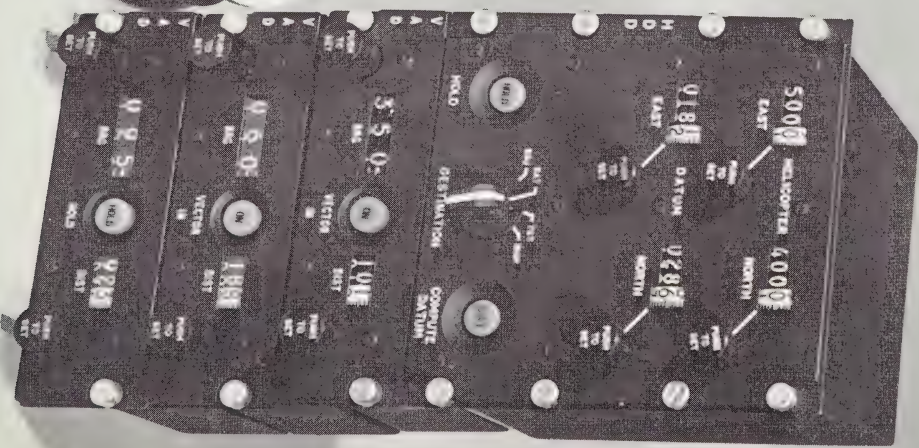
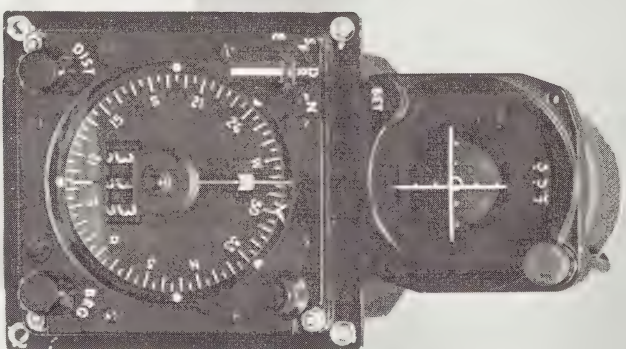
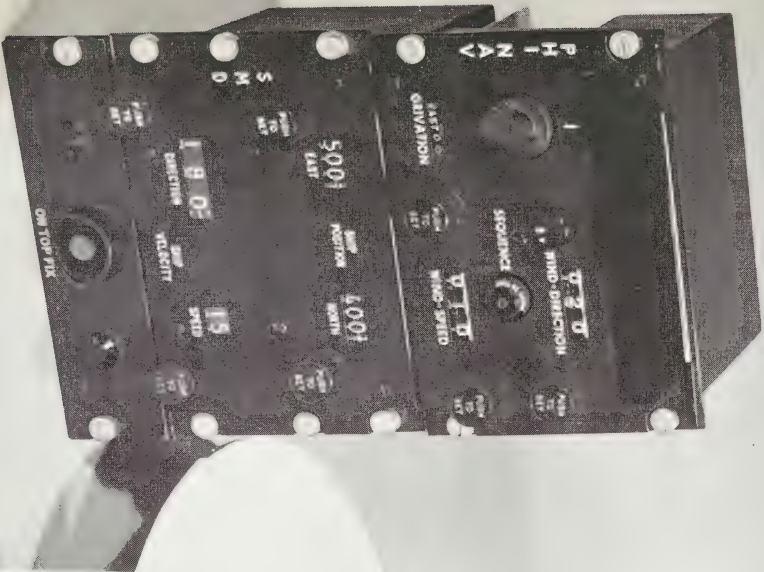
PHI-10B retains all the features of earlier PHI versions but now provides coverage of the full velocity spectrum from the zero velocity helicopter to the mach 2 fighters. It uses a building block concept, so that a basic computer can be coupled with a variety of displays and controls to create a system configuration suitable for the role of the aircraft. For example, the PHI can readily be configured to handle the highly sophisticated ASW helicopter role. In this role provision is made for routine navigation, tactical navigation, navigation with respect to moving bases or targets, with the capability of storing fixed destinations, pre-programmed search patterns, computing target datums in a co-ordinate system plus the display and control devices for all these functions.

Alternatively, the same basic computer can be configured for close support fighter use to provide both pre-programmed and in flight programmed destinations and with either or both a sophisticated area coverage map display.

Computing Devices of Canada Limited, through the development and production of this equipment together with several other navigation systems, have made available to the air forces of the free world the reliability and high degree of accuracy required with to-day's supersonic aircraft. At the same time the resources of this company continue to refine and develop existing systems and through research will offer new solutions to new problems as they appear with the same reliability which is a characteristic of the PHI.

*(For TMMD see page I-66)*





PHI 10B (ASW)  
NAVIGATION SYSTEM

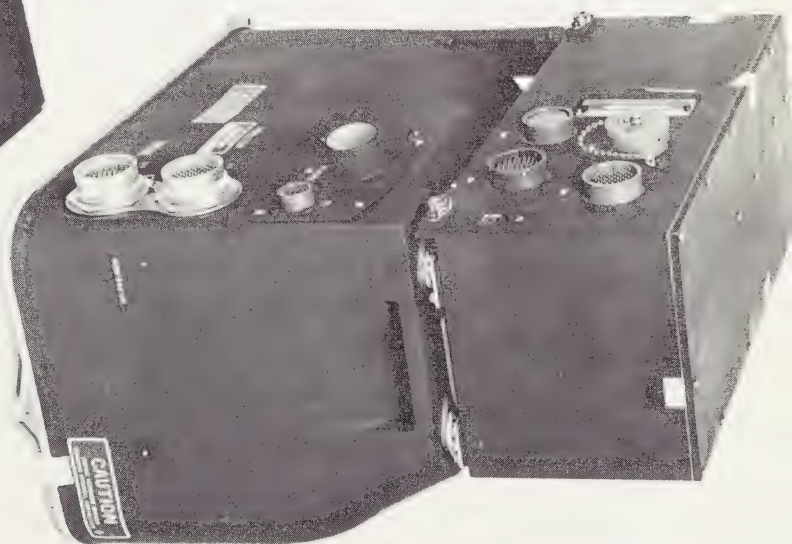
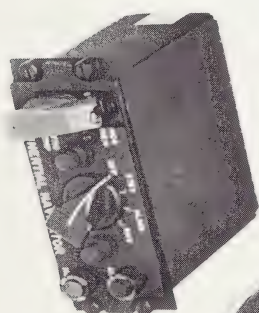
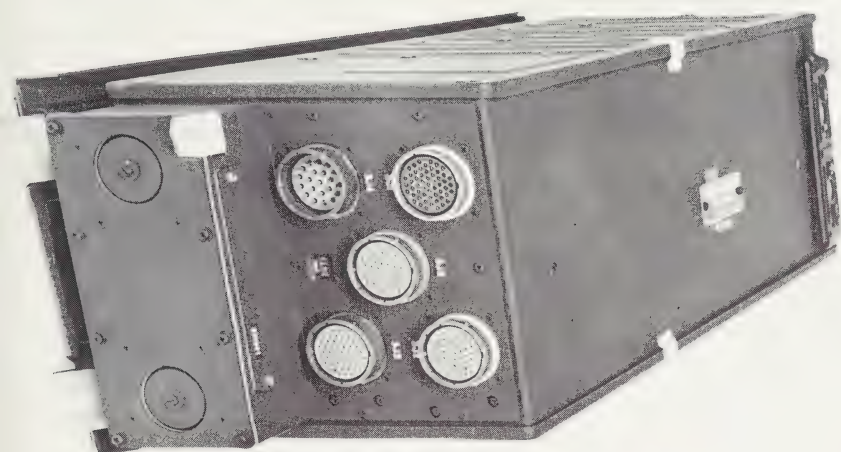
Computing Devices  
of Canada Limited

## AIRBORNE INERTIAL NAVIGATION SYSTEMS

Litton Systems (Canada) Limited has produced airborne inertial navigation systems in Canada since early 1960. Initial production was devoted entirely to the Litton LN-3 systems for the F-104 Starfighter aircraft flown by the RCAF and various European NATO air forces. Also in production now is the Litton LN-12 system for the F-4 Phantom aircraft flown by USAF. A third system, the Litton LN-15, has now been developed as a lightweight, low-cost navigation system for both military and commercial applications.

Litton inertial navigation systems are self-contained, fully automatic, lightweight inertial systems that continuously and instantaneously supply basic information on the aircraft's velocity, position and attitude during flight. These systems impose no restrictions on an aircraft's maneuverability; cannot be jammed by foreign transmissions; are unaffected by adverse weather conditions, and transmit no external signals that can be detected from outside the aircraft.

Many of the highly precise machine components which make up this equipment are produced by Rankin-Strite Limited which is a quality facility engaged in "hard core" custom machine shop work for items of this nature.





## ISIS "N" SYSTEM

The Integrated Strike and Intercept System — ISIS "N" — produced by Ferranti Packard Electronics Limited is the most recent development of the ISIS range of lightweight, low-cost fire control equipments designed for tactical aircraft. It is especially suitable for light and medium ground-attack/multi-mission aircraft where it is essential that the pilot should have a wide choice of attack manoeuvre. Principal design features are: good performance in a variety of roles: simple operation: reliability: easy maintenance: and low initial cost. The ISIS "N" System has been suitably designed for installation in the CF5, A4, MIRAGE III, and the FIAT G91 aircraft.

### SYSTEM DESCRIPTION

The Sighting Head generates a colimated reticle aiming mark consisting of a centre spot bracketed by two ranging arcs. This image is displayed in the semi-silvered reflector glass: its position is controlled in azimuth and elevation by a 2-axis eddy-current-controlled rate gyroscope. The diameter of the ranging arcs is adjusted by operation of two controls: the SPAN knob on the Sighting Head, which permits the pilot to set in any target wingspan from 25-120 ft. and the Ranging Twist Grip. Range is displayed on a dial on the Sighting Head calibrated from 2,500-600 ft. Event markers may be displayed if required. The aiming mark is roll-stabilized in the ground-attack modes by a bank signal from the aircraft reference gyro or platform. This makes tracking much easier than with a non-roll stabilized display.

Altitude/Air Speed Unit — Altitude (which is required in the computation of lead angle), and airspeed (which is required for calculating gravity-drop and incidence allowances) are measured by two aneroid capsules, which are housed in the Altitude and Airspeed Unit.

Pitch and roll signals from the aircraft reference gyro or platform are used to roll-stabilize the aiming mark and in the computation of gravity-drop allowances for actual aircraft speed and dive angle in the ground-attack modes. Alternatively, if a suitable Doppler is available, outputs of drift angle can be accepted and used in the computation of lead angle and to compensate for across track wind. A simpler version of ISIS "N" dispenses with the twist grip and embodies only a fixed value of firing range. Thus the ranging arcs are adjusted by the Span control only, and the firing range is indicated when the target fills the arcs.

Range measurement against aircraft targets is carried out stadiametrically by use of the Ranging Twist Grip. Having set target wingspan the pilot closes on the target, adjusting the twist-grip as the range closes, so as to keep the ranging arcs just bracketing the target wingspan. This gives a continuous readout of range on the range dial, and the pilot can decide to fire at any range between 2,500 and 600 ft. The Twist Grip may also be used to set the ranging arcs for a desired firing range: no further adjustment is made and the pilot fires when the target aircraft spans the ranging arcs.

The Computer contains the system power pack: amplifiers for the range and reticle servos in the sighting head: mode-selection relay circuits: the gyroscope control circuits (determining gyro sensitivity and initial sight-line deflection): and the roll-servo amplifier. It is in the Computer that the system inputs are processed to give lead angle, gravity drop and incidence allowance, across-track compensation and roll stabilization which are fed to the Sighting Head to control the position of the aiming mark.

*Growth Potential* — ISIS "N" provides considerable potential for further development. Some of the features that can be added, and for which provision is made in the basic system are listed below:

*Radar Ranging* — If the aircraft is fitted with radar, continuous radar range information can be fed to the system, thus permitting improved weapon-aiming in the air/air mode. The operation of the radar can be monitored by observation of the movement of the stadiametric ranging arcs and of the range indicator on the Sighting Head.

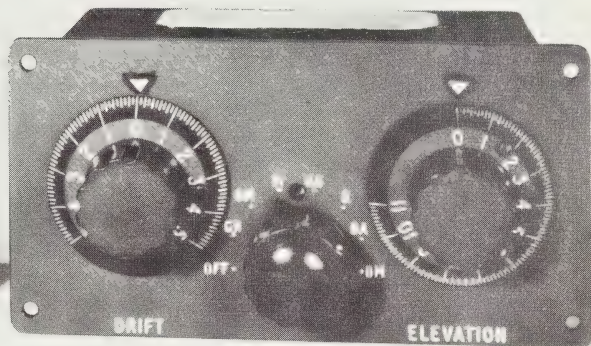
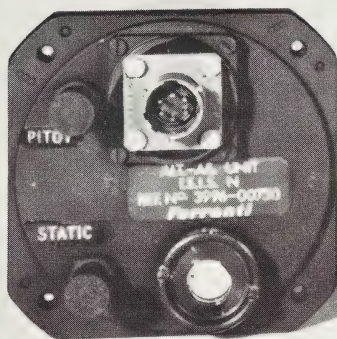
*Automatic Bomb Release* — An ancillary unit employing the Ferranti kinematic ranging technique will provide automatic bomb release in shallow-dive-angle attacks with improved bombing accuracy. This unit will also eliminate the time delay between the pilot's decision to release and the actual release.

*Level Bombing* — Additional units can be supplied to provide a level-attack capability using various weapons. The sightline-depression angles already available on the sight have been incorporated in order to cater for these modes.

*Power Requirements* — ISIS "N" operates on a 200V, 400c/s, 3-phase power supply. Power consumption is VA. A 28V d.c. supply is also required: consumption is 3W.

The Control Unit has three controls, permitting the pilot to select the following modes and weapons

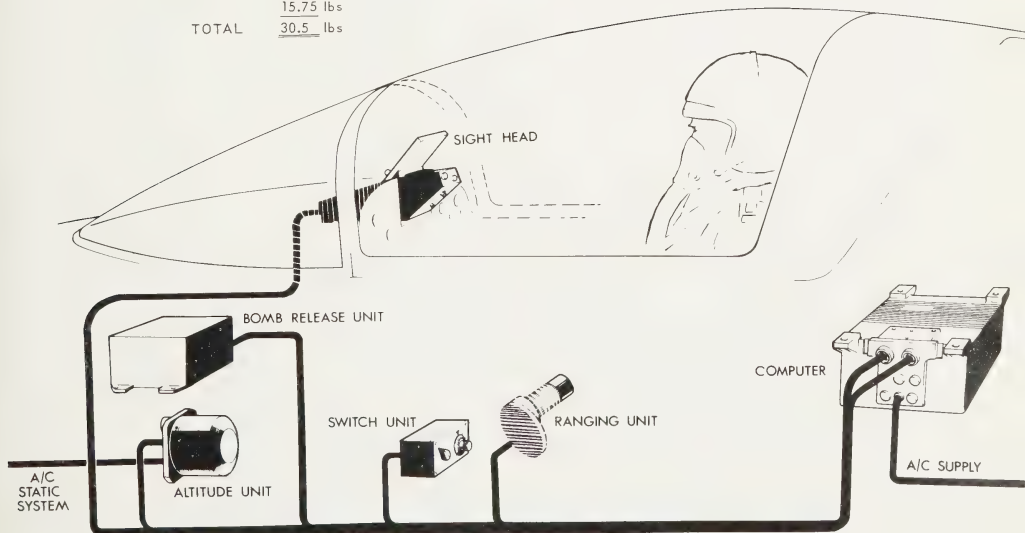
AIR/AIR	(GA) Guns	AIR/GROUND
(M) Missiles	(G) Guns	(R) Rockets
	(B) Bombs	(S) Depressed
		Sightline



CONTROL UNIT

#### WEIGHTS

In Cockpit		In Equipment Bay	
Sighting Head	13.5 lbs	Computer	15.0 lbs
Control Unit	1.25 lbs	Altitude/ Airspeed Unit	0.75 lbs
	14.75 lbs		15.75 lbs
		TOTAL	30.5 lbs



### Integrated Strike & Interceptor System

## WEAPON RELEASE COMPUTER SET (AN/ASQ-91)

Manufactured in Canada by Litton Systems (Canada) Limited, the AN/ASQ-91 Weapon Release Computer Set is an analog weapon's delivery system designed to enhance the combat effectiveness of the McDonnell F-4D aircraft. Compatibility of the weapons release computer set with the LN-12A Inertial Navigation Set used in the F-4C aircraft may be achieved through substitution of the LN-12D Output Signal Distribution Unit. The weapons release computer set provides range calculations and automatic weapons release signals for the laydown, dive-laydown, dive-toss, and offset bombing modes of operation. Steering signals and range-to-target information are supplied for use in the target-finding and offset bombing modes. Maneuver commands and the release signal are provided for successful delivery of the AGM-45 missile. Either low-drag or high-drag bombs may be used through proper adjustment of the weapons release computer control panel drag coefficient control. Maximum use of F-4C aircraft inertial navigation set output signals and electronic components and mode-sharing of weapons release computer set components has achieved substantial reductions in size, weight, and cost of the equipment.

The Litton computer set consists of:

- The **Ballistic Computer** unit which contains all of the analog circuitry required to solve the bombing problem for each mode of computer set operation;
- The **Cursor Control Panel** which incorporates two thumbwheel controls for adjusting the position of the long-track and cross-track cursors on the radar screen during the target finding and offset bombing modes;
- The **Weapons Release Computer Control Panel** which contains controls and switches for mode selection, built-in test operation, and insertion of various range, altitude, time and ballistic information.





## MK5 AIRBORNE PROFILE RECORDER

The Airborne Profile Recorder (APR), is a precision radar aid for air survey work, designed to meet topographical and planimetric requirements. It is capable of measuring ground elevations with an average accuracy of  $\pm 10$  feet (3.04 m) up to an aircraft altitude of 50,000 feet (15,240m) above sea level. The equipment provides a record of terrain clearance and terrain profile on a paper-chart recorder. The recorded data is correlated to the geographical position by simultaneous vertical photography using the MK7 Instrumentation Camera.

The MK5 APR has a very fast recording system and an expanded scale (11 inches per 1,000 feet (27.9 cm per 304.8 m)), therefore random variations of system parameters appear as a noise level of 5 feet (1.5 m) in amplitude. This small amount of noise does not affect the accuracy of the APR since it is of random nature and the reading is taken on the mean of the record.

The relative accuracy is  $\pm 10$  feet (3.0 4m) over normal terrain. With simultaneous photography, spot heights of  $\pm 5$  feet (1.5 m) are easily obtainable. This accuracy is achieved by using the hypsometer system of pressure detection. Pressure changes are detected by measuring the temperature of boiling toluene by suspending a sensing element in the vapour above the toluene. The sensing element is a thermistor which forms one arm of a bridge circuit. The bridge is balanced by coarse and fine controls on the APR console and a servo-operated potentiometer.

The reliability of the APR has been achieved by continual development and the adoption of the latest electronic techniques. Plug-in printed boards and chassis allow quick repairs to be carried out while in flight. The modular construction used ensures consistency of circuit parameters in production. The radar timing circuits, discriminator circuits and the visual monitor circuit are mounted on printed boards which are plugged into the rear printed cable board.

The military version of the MK5 APR, designated MK6 or AN/APQ-78, is standard equipment in the USAF RC-130 reconnaissance aircraft. A modified version of the MK6 APR, incorporating a binary decimal coded output to facilitate automatic data reduction, is being supplied for use in the latest USAF RC-135 reconnaissance aircraft.

The MK5 APR is in use with the major aerial survey organizations throughout the world, with operations in North America, South America, Britain, Europe, Africa, Asia and Australia. Two models are available, the Mark 5 Commercial Model and the Mark 6, which is qualified to Military Specifications. The complete system, Antenna and parabolic reflector included, weighs only 191 lbs (86.6 kg.). This equipment was designed and developed by deHavilland Aircraft of Canada Ltd., SPAR Division.

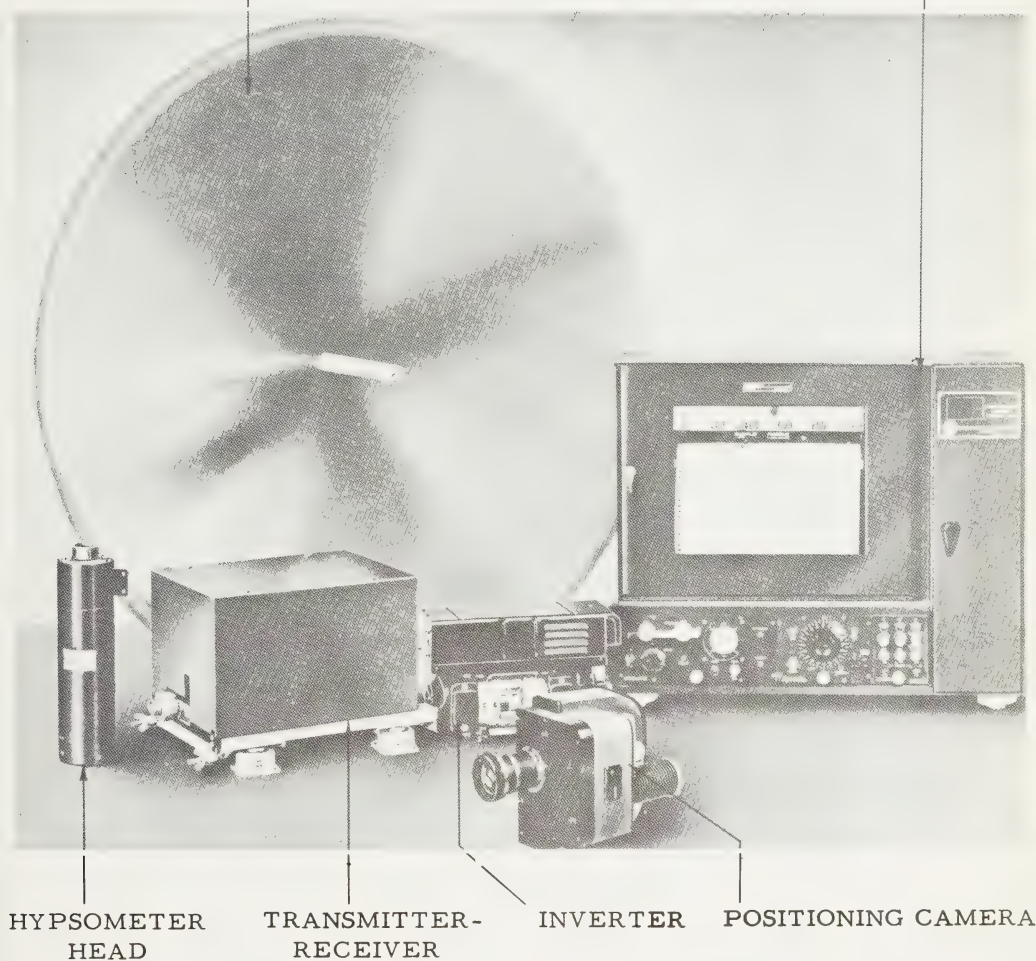
### Specifications

**Power Input:** 28 VDC, 23 amp.

**Characteristics:** *Transmitter:* Pulsed Magnetron, 3.2 cm; Peak Power, 10 Kw; Average Power, 3 w; Repetition Frequency, 2000 cps; Pulse Width, 0.10 us; Pulse Shape, Gaussian. *Receiver:* Type, Crystal Video; Sensitivity, 10-6 w; Band Width, 7 mc to 3 db. *Antenna System:* Type, Double Dipole Reflector. *System Beam Width:* Type, 10° in E and H planes to the half power points. *Operating Height:* Maximum, 50,000 feet (15,240 m); Minimum, 1,500 feet (457 m). *Record Display:* Chart Span, 1,000 feet (11 in.) (304 m) (27.9 cm); Chart Speeds, 5, 10, 15, 20 ipm (12.7, 25.4, 38 & 50.8 cm pm); Range Steps, 500 feet (152.4 m).

ANTENNA ASSEMBLY

CONSOLE ASSEMBLY



AIRBORNE PROFILE RECORDER, MK 5 - MAIN COMPONENTS



## STEM DEVICES

Each new space venture today, whether manned or unmanned, is an event of epic proportions. There are, however, certain 'first' which capture and hold the imagination of even those who are most intimately concerned with these flights. Such a 'first' was the rendezvous of Gemini 6 and 7, made even more memorable by the fact that here on Earth the conversations of the astronauts could be followed as this historic event unfolded. Communications in these spacecraft, as in all other U.S. space flights, were carried by de Havilland STEM devices.

The de Havilland Special Products and Applied Research Division has designed and manufactured a whole family of devices known as Storable Tubular Extendible Members (STEM). These devices have been used successfully as both antennas and mechanical and gravity gradient stabilization booms on satellites, spacecraft and also on ground installations. The tubular elements are formed out of strip metal, heat-treated into a circular section in such a manner that the edges of the material overlap by approximately  $180^\circ$ , thus providing the tubular element with a bending strength almost equivalent to that of a seamless tube of the same diameter and wall thickness. The elements, when retracted, are stored in a strained, flattened condition by winding them onto, or into, a drum. As the circular element is retracted it is smoothly transformed into the flattened condition by passing it through a suitable guidance system.

The wide range of antenna units produced by SPAR Division vary in length from one to one thousand feet (.3 to 304 m). Beryllium copper, stainless steel and titanium have been used to form the antenna elements. Both motorized and self-extending STEMs have been embodied in over fifty different designs with varying extension rates and tube sizes. STEMs have been successfully employed in many aerospace, military and ground applications. On spacecraft they include antennas, directional arrays, unfurlable boom structures for sensor deployment, de-spin and attitude control such as for gravity gradient satellite orientation. Some forty STEMs have been successfully launched on key scientific satellites, space probes and manned spacecraft programs.

STEM antennas are employed in the ISIS Canadian Alouette satellites I and II, with Alouette II featuring antenna extensions in space of 240 x 75 ft. (73.2 x 22.9 m) which was the longest structure yet to be orbited in space. These antennas were also employed in the GT-3 spacecraft, Mercury MA-8 and MA-9, TOPSI S-48, LOFTI, Transit, Blue Scout and Javelin, to name but a few.

The air-droppable erectable Beacon mast is a lightweight, quickly erectable ground mast to elevate and support a beacon consisting of a pair of motor driven rotating infrared lamps. The beacon assembly comprises three separate airborne packs, the light unit and accessories, the mast assembly and a battery set. (See page I-82)

The Ground Environment Elevating Mast and Antenna is capable of elevating and supporting a 100 lb. (45.4 kg) payload at an elevation of 35 ft. (10.7 m). Uses for this mast include: communications antennas for transportable vans, hardening site installations, mobile command posts and standby or emergency point-to-point communications as a monopole for operation in HF band or as a mast to elevate VHF or UHF antenna arrays, or as a combination of both. (See Page I-82)

Feasibility studies and development programs for STEM have proven that these devices, employed in ground roles, have now provided answers for compact, rugged portable or fixed ground antenna masts up to 50 ft. (15.2 m) or higher if guyed. These same equipments may be used as elevating devices for a multitude of equipments including booms and advanced military operations, mensuration and communications.



Recovery operations underway on the Gemini 6 spacecraft. The high frequency STEM antenna, used for communications during recovery operations when the capsule lands beyond visual or radar sighting, may be seen extended and in operation.







## VEHICULAR ANTENNA

Diameter	7/8" (22 mm)
Max. extended height	16' (5 m)
Retracted height	20" (50 cm)
Package platform	6"x5" (15 x 12.5 cm)
Mast material	Stainless Steel
Max. no. of nested elements	6
Extension/retraction rate	1 ft/sec. (30 cm/sec)
Max. windspeed	70 mph (110 km/hr)
Temperature range	-65°F to +165°F (-52°C+71°C)
Frequency range	15 to 114 MHz
Peak and average power	2 kw
Voltage standing wave ratio	less than 1.5 to 1
Tuning	Infinitely variable over the frequency range



## TOTEM

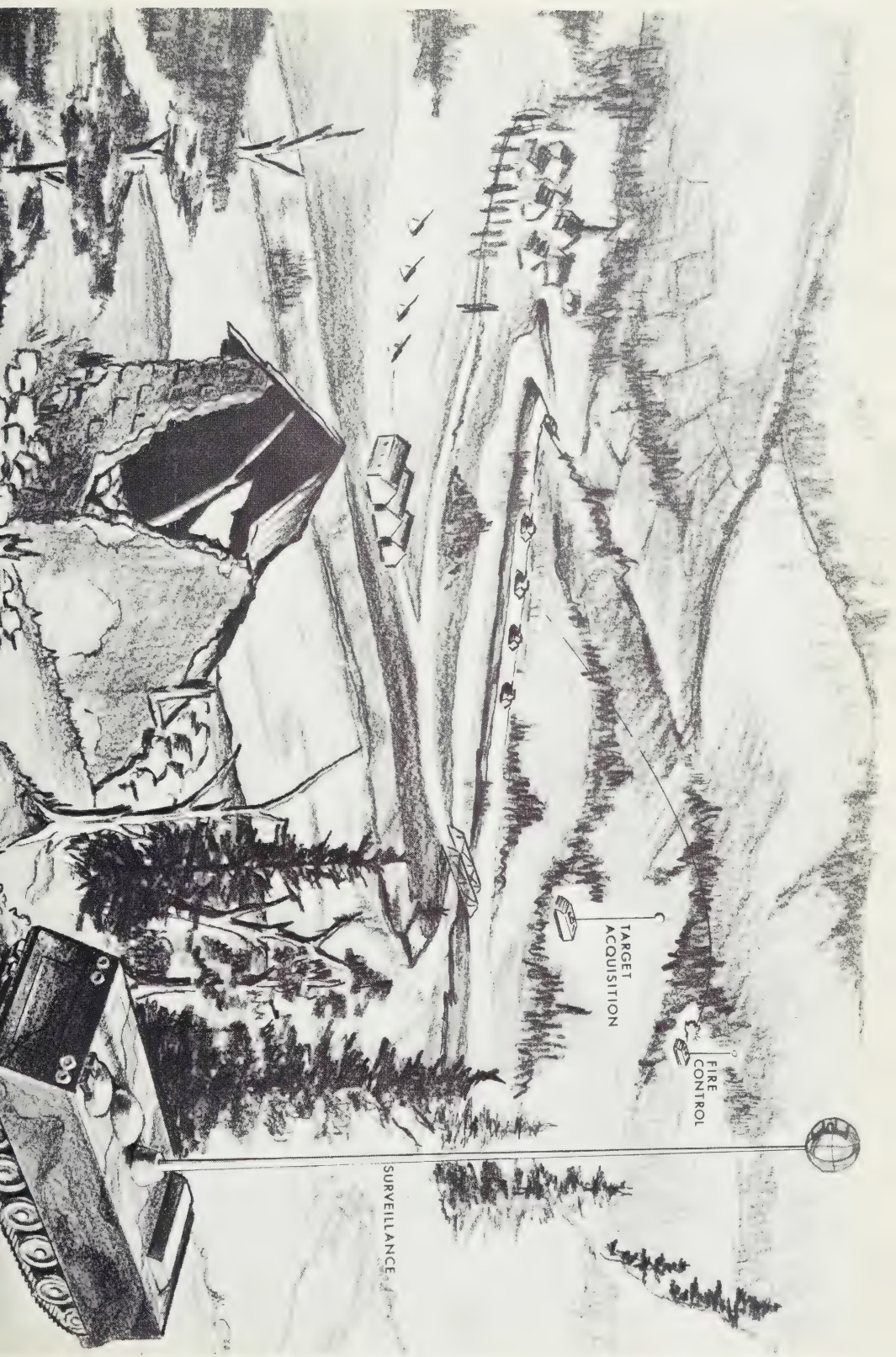
Canadian Westinghouse, and in particular the Electronics Division, has been responsible for many varied defence projects from Naval Fire Control Equipments to Air-to-Air Missile electronics.

From such experience a new surveillance device known as TOTEM has been developed. This is a high grade television system which is elevated on an extendible mast. The picture from the camera is displayed on a monitor screen which can be at the foot of the mast or at some distance from it. Camera and monitor are linked by a cable and specially stabilized structure for the camera ensures a rock-steady picture despite movements of the mast due to wind.

TOTEM provides the frontline leader with a new capability for battlefield surveillance and target acquisition and can be operated from behind cover and in concealed positions.

With TOTEM the operational area is scanned methodically. As enemy movements and targets are detected, the sensor magnification is increased permitting recognition and identification. Location of each target is determined by reference to the azimuth read-out on the monitor and to maps of the terrain.

Although designed for mounting in an armoured personnel carrier as a complete system, the monitor unit can be placed at a remote location limited only by the length of cable provided. Thus a number of TOTEMs could be deployed and their outputs observed simultaneously in a central command post.





## PERISCOPE

"Periscope" is a remotely controlled, space stabilized, tethered platform carrying a viewing system which can be used to supplement present line-of-sight missile fire control systems, to provide out-of-line-of-sight capability to existing or planned tank weapon systems, for battlefield surveillance as well as for artillery and mortar fire control. Briefly, it is an "eye in the sky".

Periscope is tethered to the ground station by means of a cable which controls flying height and provides power to the motors and the viewing device. In addition the cable is used to transmit video signals and information to the ground station located in an armoured personnel carrier or similar vehicle. The system includes azimuth orientation reference and makes provision for obtaining an instantaneous bearing relative to this reference. The Periscope may be flown at heights up to 200 meters (656.2 ft.) above ground level. This "eye in the sky", with a monitor located in a vehicle, permits observation combined with a personnel safety which was not previously possible.

Periscope is now undergoing advanced development at Canadian Westinghouse and this is backed up by research and studies being conducted at Canadian Armament Research and Development Establishment of the Defence Research Board.

Some of the more obvious uses and benefits of the equipment are as follows:

- It is possible that forward Observation Officers may now be situated in vehicles when Periscope is employed.
- Use of reconnaissance patrols, as we presently know them, may be lessened.
- Guess work associated with mortar indirect fire will be largely overcome.
- Enemy concentrations will be more easily spotted.
- Logistic savings in ammunition through more accurate ranging techniques.

With respect to operation the design criteria have ensured that pre-flight preparation, launch, recovery and post-flight stowage operations can be carried out by two men only, one being the operator, without dismounting from the parent vehicle. Other considerations ensure that the operator can carry out all flight control activities without relaxing his monitoring observations.

Technical training and knowledge requirements are of interest for they call for no greater degree of skill than presently expected with short range surveillance or ATGM equipments.

### CHARACTERISTICS

1. **RANGE:**  
Real time continuous picture surveillance coverage out to 5000 meters. (17,404 ft.)
2. **OPERATING HEIGHT:**  
Up to 200 meters (656.2 ft.) above ground level.
3. **FIELD OF VIEW:**  
Wide angle 750 mils. Narrow angle 55 mils.  
Coverage 360 degrees in azimuth and +5 degrees to -20 degrees elevation at the centre of the display.
4. **RESOLUTION:**  
Recognize a stationary medium tank at 5000 meters. (17,404 ft.)
5. **SIZE AND WEIGHT:**

Rotor diameter	4.5 ft. (1.4 m)
Weight of airborne system	80 lbs. (36.3 kg)
Total System Weight, including ground element, approx.	500 lbs. (226.8 kg)
6. Ascent to maximum altitude—60 secs.  
Complete recovery operation—90 secs.
7. Azimuth bearing read-out relative to Magnetic N. +20 mils.
8. Vehicle installation—M113 APC or similar vehicles.



ONE CONFIGURATION  
OF PERISCOPE

## THE BLACK BRANT RESEARCH ROCKET FAMILY

The Black Brant research rockets have been specifically developed for scientists who wish to conduct experiments in the upper atmosphere. The family is composed of four rocket systems which provide a capability of lifting scientific payloads weighing from 40 to 500 lbs (18.1 to 226.8 kg) to altitudes of 75 to 620 miles (120.7 to 997.8 km).

Bristol Aerospace Limited, the developer of these Black Brant rockets, has participated in launching Black Brants from the Pacific Missile Range, California, Eglin Air Force Base in Florida, the NASA Wallops Island Range in Virginia and from Canada's Churchill Research Range.

A brief review of characteristics of each of the Black Brant rockets and supporting instrumentation is outlined below:

The Black Brant III is the smallest rocket in the family, measuring 10" (25.4 cm) in diameter and 18.06 ft. (5.5 m) long. With a nominal thrust of 10,800 lbs. (4900 kg) it can lift 50 lbs. (23 kg) scientific payload to an altitude of 110 miles (177 km). This compact single stage solid fueled rocket has excellent performance when compared to competitive two-stage rockets commonly used for this altitude range.

The Black Brant IV is a two-stage solid propellant rocket capable of lifting a 50 lb. (23 kg) scientific payload to an altitude of 620 miles (998 km). It is simply a combination of the 17" (43.1 cm) motor used for Black Brant V-A with a Black Brant III rocket. The combined length is 37 ft. (11.3 m). Its simplicity and reliability as a two-stage rocket are basic design features.

The Black Brant V-A solid propellant rocket measures 17" (43.1 cm) in diameter and 25 ft. (7.6 m) long. With a nominal thrust of 25,000 lbs. (11,340 kg) it can lift 150 lbs. (68.1 kg) scientific payload to an altitude of 132 miles (211 km).

The Black Brant V-B is a highly sophisticated vehicle using a modern solid propellant which results in this 17" (43.1 cm) diameter, 25 ft. (7.6 m) long vehicle lifting 200 lbs. (88 kg) of scientific payload to an altitude of 270 miles (392 km).

The Black Brant vehicles which were designed and developed to the requirement of the scientific community are now being utilized by an ever increasing number of scientists in Canada, the U.S.A., and Europe.

In addition to the Black Brant rocket vehicles, Bristol offers the users a complete line of telemetry, diagnostic flight instrumentation, and auxiliary equipment designed and built at our Winnipeg Plant. Bristol's total capability also includes design and construction of payload structures, payload integration and check-out, launch services and data reduction.

Continuing development is carried out at Bristol to assure keeping in step with the changing demands of the world's scientific community.





## GUN FIRED VERTICAL PROBES

### PROJECT "HARP"

McGill University has developed a technique for soundings of the upper atmosphere using gun launched probes. For this programme a 16" (40.6 cm) naval gun, smooth-bored to 16.4" (41.7 cm) is used to launch, with the aid of sabots, fin stabilised vehicles carrying both chemical and electronic payloads to altitudes of well over 62 miles (100 km.). All vehicles bear the code name 'Martlet'.

The Martlet I airframe is designed to carry 16 litres of gas at pressures up to 250 atmospheres in the after body, with a 25 pound (11.3 kg) telemetry payload in the nose. Flight altitudes are up to 62 miles (100 km.).

The Martlet II airframe was developed to fly liquid payloads to altitudes up to 93 miles (150 km.) carrying a small instrumentation and telemetry package in the nose. These vehicles have been used successfully to release, as a trail, an 80% tri-methyl aluminum, 20% tri-ethyl aluminum mix. The luminous trail produced above 57 miles (92 km.) has been photographed in the standard manner, and wind profiles obtained. The vehicles have been manufactured by Heroux Machine Parts Ltd., with the release valve being developed and produced by Aviation Electric Limited.

The Martlet III airframe is a rocket assist vehicle capable of placing 50 pounds (22.6 kg) of payload to altitudes of over 187 miles (300 km.). It is currently under development, numerous prototypes having been successfully flown using rocket motors produced by Canadian Arsenal Ltd. The rocket flights are monitored using multi-channel potted telemetry, developed and manufactured by Computing Devices of Canada. Airframes are built by Aviation Electric Ltd. and Heroux Machine Parts Ltd.

Other airframes are under development in the programme. These are aimed at achieving larger payloads and altitudes in the thousands of kilometers.

The gun-launched probe is not influenced by surface winds, and suffers little dispersion from its predicted trajectory. With active programmes under way to modify a wide range of sensors to withstand launching stress, its range of application is continually increasing. Firings are being conducted continually at the Barbados range site, bunched firings having been conducted at the rate of one every hour and a half for periods of over twelve hours. The range is operated under contract from McGill University to Computing Devices of Canada, and is instrumented to provide photographs and radar coverage, both from Barbados itself and from bases on nearby islands. Most firings are supported by the down range facilities of the Atlantic Missile Range.

*(For associated equipments and technologies see pages I-92 & I-94)*





## HIGH "G" ELECTRONICS

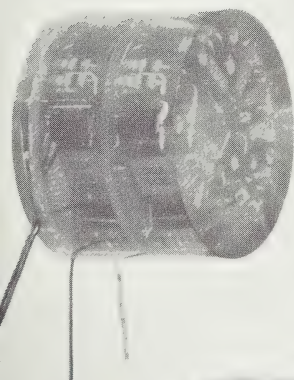
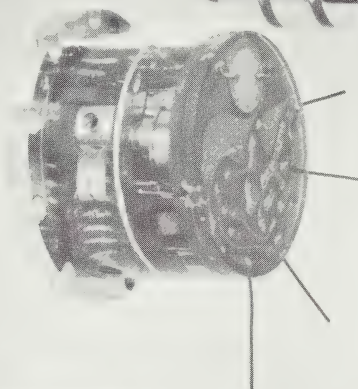
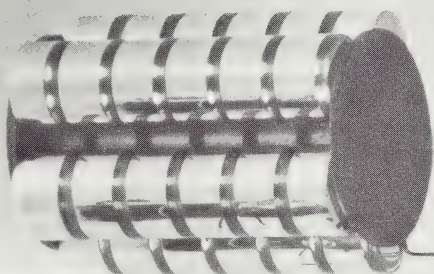
Computing Devices of Canada Limited has been engaged in aerophysics research since 1956. One of the major activities is the study of high g electronics.

The 'Space Age' has brought increased requirements for the decision and construction of high g telemetry systems. Sensors, power supplies, voltage regulators, frequency modulators, sub-carrier oscillators, multi-channel commutators and transmitters are being developed at the company. High g telemetry units are being marketed for applications in data transmission systems for models launched in free-flight ballistic ranges, gun-launched meteorological and upper-atmosphere probes, hard-landing space probes, for applications involving high-speed machinery and for high-acceleration missiles and rockets.

Solid state telemetry systems with 215-250 megacycles per second (Mc/s) FM transmitters operating at power levels up to one watt have been designed and packaged to operate in a 50,000 g environment. These systems are available now for high g telemetry applications.

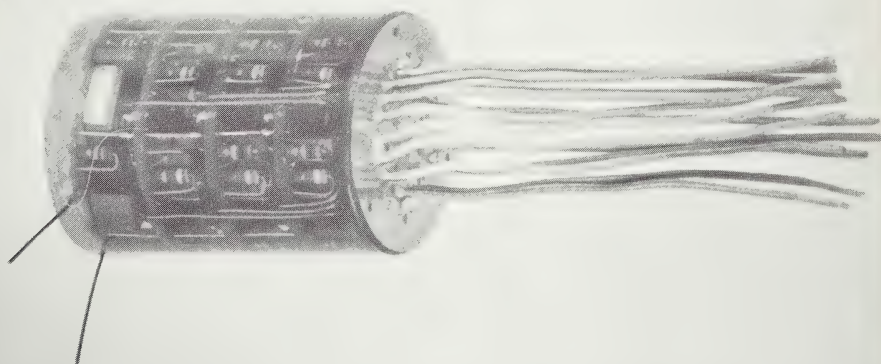
Using the company's high g testing techniques, components and sub-system evaluation and selection, work is proceeding for ballistic range telemetry applications where g forces will range from 250,000 to 500,000. For upper-atmosphere (above 300,000 ft. (91,440 m)) research probes, telemetry transmitters are being developed in the microwave frequency range, and a high g Langmuir probe is being developed for high-altitude electron density measurements.

The company is also developing an FM transmitter which will operate at a degree of frequency stability never before attained in high g electronic development. This 250 Mc/s transmitter can be used in a hard-landing space exploration instrument which transmits its deceleration time signature when impacted on various materials.



*Computing Devices*  
OF CANADA LIMITED

**AEROPHYSICS**



## HIGH "G" TECHNOLOGY

Aviation Electric Limited has been acting as sub-contractor since 1962 to the High Altitude Research Project (HARP) being conducted by the Space Research Institute of McGill University. With the sounding vehicles being launched by 16 inch (40.6 cm) naval guns where extremely high 'g' loadings are present at the launch, a major problem was encountered when existing systems and components were not capable of resisting these extreme loads. Through research, development and production elements have been produced which will withstand up to 10,000 g.

The components which are illustrated are a high altitude guidance system for the Martlet IV vehicle. These include sun sensors, infra-red telescopes and potted electronic moulds, the low cost optical instruments and their solid state electronic circuits identify earth-line and sun-line to within a fraction of a degree. Coupled through electronic logic modules to fast-acting nitrogen valves, these instruments are used to process the roll-axis of the spinning vehicle onto its pre-determined course.

Horizon Sensing is accomplished through use of two infra-red telescopes mounted rigidly to the vehicle which scan from space to earth to space as the vehicle spins. Each of these telescopes has a field of view of approximately  $1^\circ$  and their 'look' angles are symmetrically displaced by  $30^\circ$  either side of a plane perpendicular to the vehicle roll axis and in a plane containing the roll axis. The sensing element is a strengthened bolometer bridge and as the field of view of the telescope crosses the earth a voltage pulse is generated whose time base is indicative of the time required for the telescope to sweep across the surface of the earth.

Sun Sensing is accomplished through use of photovoltaic cells placed in a specially shaped cavity with reflecting and shielding surfaces arranged to give a voltage output pulse once during each vehicle rotation. The amplitude of this pulse is proportional to the angle between the sun line and a reference plane normally taken to be perpendicular to the vehicle roll axis. The auxiliary and rear sun sensors are used to provide all-round coverage so that if the vehicle should tumble or be oriented so that the sun falls outside the field of view of the main sun sensor, attitude information can be obtained and the vehicle can initiate emergency pitch-out or yaw-out manoeuvres.

Spin Rate Sensing is accomplished through use of a mass spring accelerometer which features pneumatic plus frictional damping and a specially constructed potentiometer pick-off. It is mounted with its sensitive axis at right angles to the roll axis of the missile with the seismic mass located at a radius of 6 inches (15.2 cm) from the missile center line. At this radius the nominal spin speed produces a radical acceleration of 15.3 g. The accelerometer is provided with limit switches to activate the roll jets whenever the spin rate is below 4.4 rps or above 5.6 rps. Between these limits the actual accelerometer resistance is used by the logic circuits to compensate for variation in sampling frequency (spin speed).

The Reaction Control Equipment consists of four valve/nozzle combination units, a fill valve, an explosive cutter valve and a pressure regulator in addition to the nitrogen storage tank and associated plumbing.

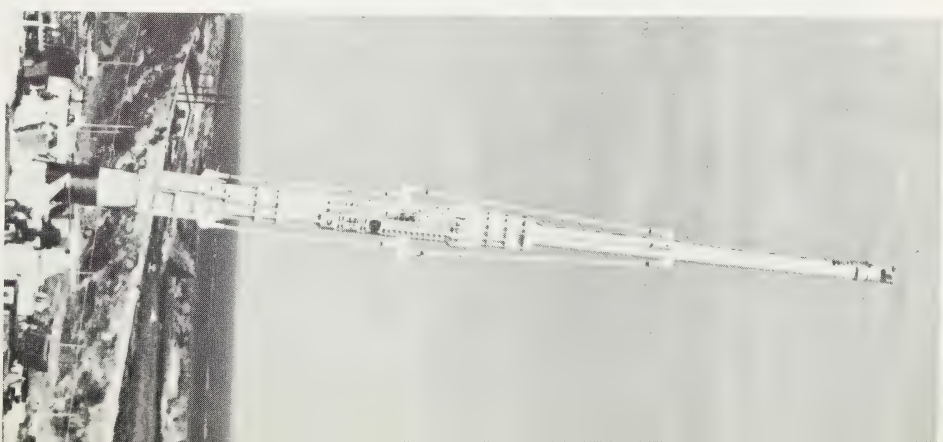
Computation and switching logic is supplied by solid state circuitry which is potted in a mixture of fine sand and epoxy resin.

An intermittent fluid release valve has also been developed in conjunction with HARP. As a part of the program, air currents at altitudes of up to 400,000 feet (121,920 m) are studied by releasing a stream of reactive liquid, in this case TMA — trimethyl aluminum, and observing the distortion of the resultant trail over a period of 15-30 minutes. Both continuous and interrupted trails are used — the interrupted trail having the advantage of vertical as well as horizontal wind shear determination plus an extension of the altitude range over which observations can be made with any one shot.

The valve design incorporates a bistable fluid amplifier which uses the TMA as both a power and a control source. The fluid element alternately switches the TMA flow into a storage volume and then to atmosphere, while the fluid in the storage volume is being dumped overboard. The valve is completely self-contained, requiring no power supply, exterior control, or even a start signal. It is screwed into the rear of the vehicle and automatically begins releasing an intermittent stream when the high pressure TMA is admitted. A spool valve controlled by a pure fluid element operates to ensure complete cut-off of the TMA flow and also serves to keep the flame from the burning TMA from working back into the valve components during the cut-off portion of the cycle. Because of the requirement for complete cut-off, use of a vented fluid element was not practical.

The complete valve is of cylindrical shape, 4 inches (10.2 cm) in diameter by 3 inches (7.6 cm) long and weighs 3 lb. (1.4 kg).





Illustrated are components of a guidance control system for the Marlet IV space vehicle. The control equipment consists of infrared telescopes, sun sensors, spin rate sensors, solid state electronic logic modules and reaction control valves which operate to provide the desired pitch and yaw attitudes. The equipment is self-powered by a specially encapsulated battery-pack and is required

## PRECISION SATELLITE TRACKING ANTENNA

The Northern Electric Company, Research and Development Laboratories, has completed the design, installation and testing of a precision 30 foot (9.1m) tracking antenna for the Defence Research Telecommunications Establishment at Ottawa. Canadair Limited of Montreal was the major subcontractor for the design and installation of the structural parts. In view of its test facility role of a general nature, such as satellite communications and atmospheric propagation research, the antenna has been specially designed to provide the most flexible operation.

In order to get useful measurements of atmospheric effects on propagation in the severe Ottawa climate, the antenna is designed to operate without radome protection. In addition, the reflector has good rain drainage, and the feed horn is heated for removal of snow. As a result, the antenna is kept relatively free of the effects of accumulated rain or snow during measurements.

An additional advantage which is available with the horn reflector feed configuration is that, because of the inherent right angle bend, it can pass through the elevation bearing as it does on this antenna, allowing the receiving equipment (and transmitting equipment) to be housed in an always level enclosure on the azimuth platform. Being free of the yoke space restrictions, this enclosure has adequate space for personnel and equipment.

Another feature of the antenna structure is the high degree of surface accuracy. The centre 10 feet of the main dish is a one piece machined portion of the paraboloid, which is supported by a 10 foot (3.05m) diameter cylindrical trunnion. The outer part of the dish is made up of 24 petals of 2 inch (50.8 mm) aluminum honeycomb construction, supported on backup frame sectors. The overall surface accuracy is 0.022 inches r.m.s., including effects of 40 m.p.h. (64.4 km) wind,  $\frac{1}{4}$  inch (6.4 mm) of ice, thermal expansion, inertia, and static tolerance.

The Cassegrain supports are designed for minimum aperture blockage consistent with the high stiffness requirement which results in a minimum resonant frequency for the complete structure of 5 cps.

The simultaneous operating frequencies for the antenna and feed are approximately 4 Gc/s, 8 Gc/s and 16 Gc/s with a maximum useful frequency of 35 Gc/s where antenna gain of over 64 db has been achieved. High aperture illumination efficiency is achieved in a broadband sense over the frequency range through the use of a Cassegrain configuration with a horn reflector feed operating in the near field zone. This feed system coupled with a "Multi-Mode" angle tracking technique results in a broadband, low noise, highly efficient antenna.

The "Mode Coupler" which is located in the equipment house operates on received signals from the feed. These are circularly polarized in the dominant mode at 4 Gc/s, 8 Gc/s and 16 Gc/s and in the  $TM_{01}$  mode at 4 Gc/s from which angle error information is derived for auto-tracking.

The electrical drive system employs low speed torque motors with integral tachometers and low ratio gear boxes. These are arranged in opposing pairs on each axis forming an anti-backlash dual drive. The features of this technique are low inertia, and high precision and stiffness.

The antenna control equipment is a compact all-digital equipment providing for operation of the antenna in manual, standby, and computer track modes. The computer itself is external. The resolution of the resolver type shaft encoders and readouts is  $0.01^\circ$ . The absolute pointing accuracy of these modes of operation is  $0.03^\circ$  peak. This includes all effects of environment and inertia.

The servo system is type II with an acceleration constant of 10.

Signals from the mode coupler are processed in a phase lock receiver consisting of three doppler tracking channels, one associated with each of the channels and a composite angle tracking channel. The outputs of the error channel are proportional to boresight error but in antenna aperture coordinates. The coordinate conversion used to account for the elevation rotary joint in the feed, and secant sensitivity correction for azimuth, is carried out in a modulator resolver demodulator system.

In the auto-track mode, the total peak pointing error from all sources is  $0.01^\circ$  when the signal level is  $-125$  dbm and with a receiver noise temperature of  $450^\circ\text{K}$ .

Provisions have been made in the design to make the antenna useful for a wide variety of experiments, by incorporating a high degree of flexibility. Chiefly, the features are low noise, high power handling capacity, high frequency, precise pointing and generous equipment space located on the antenna.





## SATELLITE AND MICROWAVE RELAY COMMUNICATIONS

An example of the competency of Canadian industry to serve her own needs and those of other countries is the communication satellite earth station completed for the Department of Transport. The station, located on Canada's eastern seaboard at Mill Village, Nova Scotia, is linked to the world-wide network of high capacity ground stations to provide trans-Atlantic voice and TV communications with satellite systems launched by Communications Satellite Corporation. The station is made up of four major systems (antenna, acquisition and tracking, wideband communications, and instrumentation and control) and 14 subsystems. The antenna is 85 ft. (25.9 m) in diameter with a Cassegrainian feed system and is enclosed in a 120 ft. (36.6 m) diameter inflatable radome. The electronic circuits employ the latest solid state devices. One example of the precision of the system is the antenna pointing accuracy of  $0.02^\circ$ . The station is now providing communications with the Intelsat I and II synchronous satellite systems. A second station will be built at the Mill Village site during 1967.

Space Systems of RCA Victor Company, Ltd. of Montreal was the system manager for this station and, in addition, manufactured 4 communication and control subsystems for which it has established proficiency. The Company can furnish the same or similar high capacity communication satellite earth stations on a turnkey management basis. Arrangements can be made to train personnel in the technology of satellite communications, and operation and maintenance of a station; and, more significantly, assist countries in establishing "home" content for much of the electronic and mechanical hardware for the station.

Space Systems of RCA Victor engages over 135 scientists and engineers, supported by 61 technicians, for its space electronic work. Over 57 space electronic programs have been performed covering earth stations, satellites and satellite systems, and space research studies. This work has been performed for 34 separate space agencies. Space research covers laser communications, laboratory simulation of geophysical effects, re-entry communications, ionic propulsion, cryogenics, and radar detection of satellites and missiles through plasma sheath effects.

Space Systems of RCA Victor has discharged 14 earth station programs and stands to render service in study of projected international traffic requirements, preparation of specifications for the earth station and associated telecommunication facilities and civil works, and site survey and site selection.

Communication satellite earth stations provide great increase in the quality and traffic handling capacity of a country's international communications. This, in turn, creates the need for additional high capacity, terrestrial microwave relay trunk circuits and low capacity spur circuits for the country's internal communications. RCA Victor Company, Ltd. has specialized in high performance radio relay communications systems for 22 years and now provides solid state equipment with capacities from 60 to 1800 voice channels. Considerable engineering know-how has been accumulated by the system design, equipment manufacture, and installation of over 20,000 route miles (25,748 km) in thirteen countries of the world. The majority of these high capacity systems carry defence traffic.



## COUNTER-MORTAR RADAR AN/MPQ-501

This Counter-Mortar Radar equipment was developed for the Canadian Army by the National Research Council and was production-engineered and produced by Raytheon Canada Limited. The AN/MPQ-501 equipment is a mobile microwave radar for the field forces designed to locate the source of hostile mortars, rockets, and other high-angle artillery. It also has demonstrated its ability to locate field artillery and provide rapid registration of counter gunfire. Designed for mounting on an armoured vehicle of the M113 and other types, the radar has a high degree of mobility, enabling it to move rapidly to site, perform its function, and then quickly move away. The air transportability of this equipment, when mounted on such an armoured vehicle, has been demonstrated by the RCAF when they transported tactical vehicular installations of this radar equipment non-stop to Europe from the RCAF Downsview airport in a C130 Lockheed Hercules cargo aeroplane.

The AN/MPQ-501 will perform the following functions:—

- (a) Accurate location of hostile mortars and other high-angle artillery.
- (b) Registration and adjustment of divisional artillery.
- (c) Location of hostile ballistic rocket positions.
- (d) Combat area surveillance.
- (e) Survey of own and other positions.

### *Outstanding features of Radar AN/MPQ-501*

- 5 minutes into action and 2 minutes out of action—day or night.
- One man setup and operation without exposure.
- Fully automatic antenna levelling.
- Automatic loading and stowage.
- Automatic time insertion, beam centering and shifting.
- First round location.
- Simultaneous fire capabilities.
- True presentation of signal pairs to avoid confusion.
- Single beam extrapolation provided.
- Locations in both cartesian and polar co-ordinates.
- Fall of shot corrections direct on counters.
- Fast automatic computer clearing between rounds.
- No trailer, no field cables—self-contained and powered on single armoured vehicle allowing maximum mobility.
- Fully air-conditioned including N.B.C. protection.
- Frequency, power, noise figure and tuning monitored.

Raytheon Canada Limited is equipped to design, develop, and manufacture high quality radar systems such as the AN/MPQ-501, as well as communications radar equipment for airport and airways surveillance.





I-101

## IONOSPHERIC MEASUREMENT

From the Research Laboratories of EMI-Cossor comes an entirely new concept in the ionospheric measurement field, the Model 8000 Ionosonde. This ionosonde will shatter the notion that equipment for ionospheric measurement and study must require several racks to accommodate it, and also a team of highly skilled personnel to operate it. By utilizing solid state circuitry wherever possible, and advanced design techniques, EMI-Cossor have produced a Vertical/Oblique Sounding Terminal equipment which can be literally carried around and operated by a single person.

With this system new concepts and environments for ionospheric observations are now possible, particularly in the mobile vehicle field.

This equipment is applicable for both Point to Point and Mobile Operations.

The design of the equipment is entirely electronic with no switches, relays, rotary capacitors or other mechanical devices. The only tubes used are in the transmitter high power stages. A binary number (128) has been chosen for the total quantity of frequency steps in order to simplify basic design and also to facilitate future potential features of digital processed type readout.

Integrating characteristics at Low S/N ratios are assured by the use of coherent detection in the receiver.

The equipment is designed for 19" (48.3 cm) rack or table mounting, and has exterior dimensions of 19" wide  $\times$  18¼" deep  $\times$  16" high (48.3  $\times$  46.4  $\times$  40.6 cm). Weight is approximately 100 lbs (45.4 kg.). Power requirements are 115 volts (50 to 400 cycles) at approximately 300 watts.

The 8000 Ionosonde has a Polaroid type camera supplied as standard equipment. This camera, using Polaroid Land Film will provide developed ionogram prints from the ionosonde in just 10 seconds. A guide attachment arrangement is provided for rapid easy removal of the camera when not in use.

Optional extras and companion equipment available include: Programme unit for automatic programming of the ionosonde to operate at pre-determined intervals; 35 mm Camera of 100 feet (30.48 m) reel capacity and with built-in Time-Date exposure facility. This camera requires the above programme unit as a driven source; 30 Kilowatt pulse power amplifier module for very long sounding circuits and Electronic integrating and storage unit for highest S/N ratio, amplitude-frequency readout, and data processing applications.

### Technical Details:

*Frequency coverage:* 1.8 Mc/s to 28.8 Mc/s in 128 frequency steps spaced in an exact logarithmic progression, to give a constant frequency resolution through the band of approximately  $\pm 1\%$ . *Power output:* 4 kilowatts R.M.S. pulse power. *Pulse widths:* 25, 50, 100 or 200 microsecs. (6dB. points). *Pulse envelope:* Sine squared for minimum interference with neighbouring receivers. *Receiver bandwidths:* 16, 8, 4 or 2 Kc/s net pulse bandwidths. *Receiver dynamic range:* At least 50 dBs. *P.R.F.:* 64 Pulses/sec. *Band sweep period:* 2, 4, 8, 16 or 32 sec. *Receiver tuning:* Solid State Filters. *Display:* B type 5" display with long persistence screen for direct observation, and also provision for Polaroid or 35mm camera recording. *Integrating characteristic with high level C.W. interference:* Excellent. *Timing accuracy:*  $\pm 1$  part in  $10^8$ . *Standard antenna impedance:* 50 ohms or to special order. *Height Markers:* Every 100 kilometres for vertical scaling. *Frequency Markers:* Every  $\frac{1}{2}$  frequency octave + electronic strobe with calibrated dial.



EMI  
ONSCOPE  
MODEL 84-8000

RECEIVER  
TUNING  
COUNT  
RANGE  
BAND  
CENTER  
CAL  
ZERO

TUNING UNIT  
COUNT  
RANGE  
BAND  
CENTER  
CAL  
ZERO

TRANSMITTER  
TRANSMITTER  
TUNING  
COUNT  
RANGE  
BAND  
CENTER  
CAL  
ZERO

POWER SUPPLY  
POWER  
FUSE  
LUM  
BRIGHT  
C.T.  
REAR CHARGE  
STROBE  
HOLD  
AUTO

POWER SUPPLY  
POWER  
FUSE  
LUM  
BRIGHT  
C.T.  
REAR CHARGE  
STROBE  
HOLD  
AUTO



## LOW NOISE PARAMETRIC AMPLIFIERS

The Northern Electric Company Limited has designed and developed a wide range of low noise parametric amplifiers for use in troposcatter communication systems and military search radars. Seven different types of amplifiers have been manufactured to date, accounting for over 1000 units in use throughout the world.

Parametric amplifiers are used wherever a small signal is to be amplified with low noise contribution. The amplifier finds its way into troposcatter communication systems and is responsible for the relatively small antenna size and practical transmitter power.

Northern's amplifiers have been used by USAF, NATO forces, CNT, A.T. & T., Bell Telephone Company Limited, and The British Columbia Telephone Company. A typical installation is the BMEWS system.

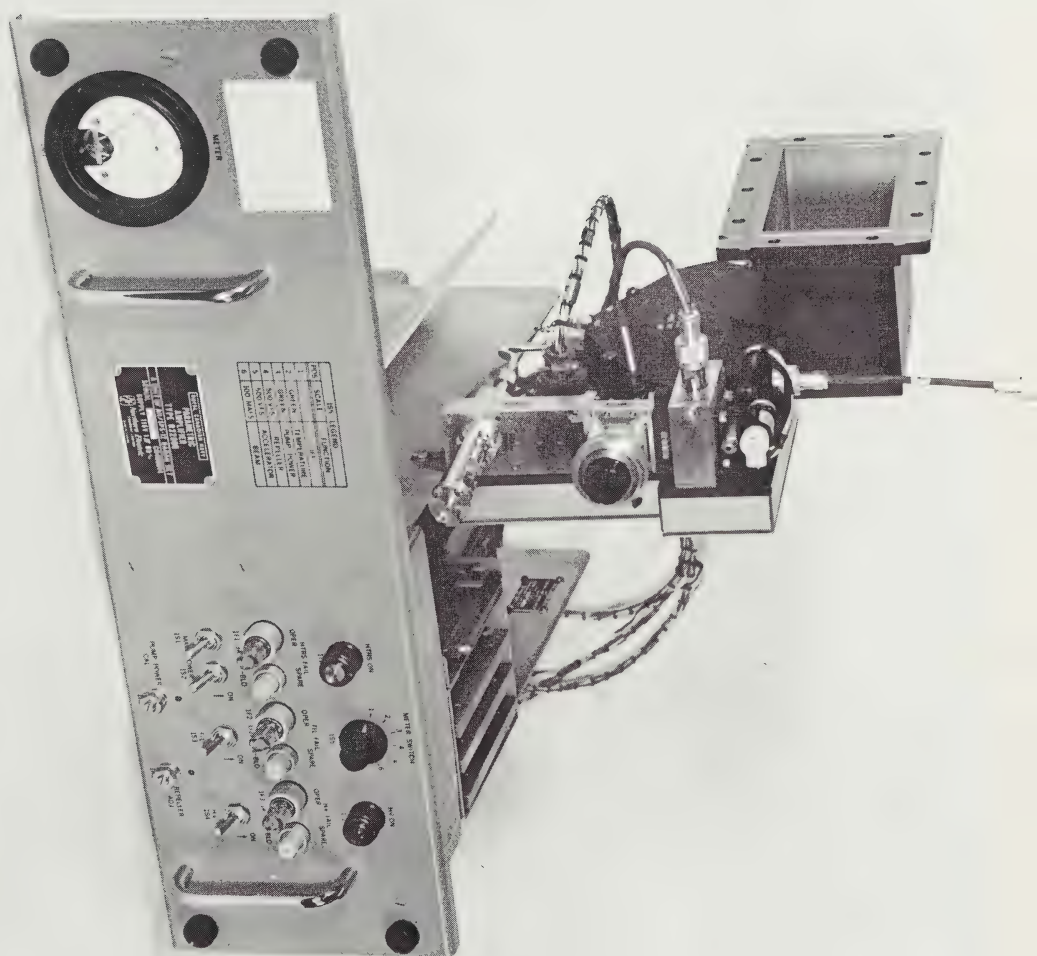
The latest application is in search radars where the amplifier is used to improve the range performance without increasing the transmitter power. Such an application (as shown in the photograph on the opposite page) was designed for the Royal Canadian Navy in conjunction with their ship-based search radar, SPS-12, and is installed as a modification kit.

All parametric amplifiers designed by Northern Electric are one port tunables and feature typical noise figures ranging from 1.8 to 2.5 dB depending on the type of amplifier. Operating frequencies of the various models cover the 755 MHz to 2700 MHz range, with a bandwidth of 10 MHz to the 1 dB points.

Simplicity and reliability are enhanced by single control tuning and a completely solid state power supply. Mechanically, the amplifiers are completely self-contained and are available in a variety of configurations ranging from standard rack mounted models to pull-out rotatable drawer units. Simple temperature compensating circuits maintain stable amplifier performance over severe environmental conditions. All amplifiers are designed to meet very rigid military specifications and are unconditionally stable with any combination of source and load impedance.

The Company's Research and Development Laboratories are continuing investigations to improve parametric amplifier performance in troposcatter, line-of-sight, radar and satellite communication systems.

**SPECIFICATIONS:** *Model:* R22800. *Typical noise figure:* 1.8 dB. *Gain:* 18 dB  $\pm$  2 dB. *Bandwidth:* 10 MHz (3 dB). *Operating Frequency:* 1.250 to 1.350 KMHz. *Input-Output VSWR:* 1.2:1. *Linearity:* -35 dBm. *Klystron Frequency:* 10.6 KMHz. *Power Supply:* Regulated Solid State Silicon. *Primary Power:* 115V  $\pm$  10%. *Operating Environmental Temperature:* 0°C to 50°C. *Military Specification:* MIL-E-16400. *Weight:* 50 lbs. (22.7 kg).



## DUAL KEYS, FREQUENCY SHIFT EXCITER

The type DFS-21 Dual Keyer, Frequency Shift Exciter was developed by Topping Electronics to meet modern requirements for a high stability unit which could be easily adjusted to any desired small shift without constant readjustment. The exceptional frequency stability is achieved by use of crystal controlled oscillators throughout, and special means for shifting the crystal frequencies. The output frequency may be changed without affecting shift circuits by replacement of a single crystal. A single control is also provided to vary the entire shift spectrum by  $\pm 40$  cps.

The unit combines the functions of a Dual Keyer, Frequency Shifter and Exciter. Channel separation can be adjusted to be anywhere from 5 to 90 cps. Separation of 31.4 cps would require only a single channel NATO bandwidth of 95 cycles, but with this equipment, results in transmission of two messages.

The following table shows output frequencies with channel separation of 49.5 cps with dual frequency shift:

KEYING CONDITION		OUTPUT FREQUENCY	
<u>Ch. 1 Ch. 2</u>			
S. S.	NOMINAL FREQUENCY	—	74.25 cps
M. S.	NOMINAL FREQUENCY	—	24.75 cps
S. M.	NOMINAL FREQUENCY	+	24.75 cps
M. M.	NOMINAL FREQUENCY	+	74.25 cps

The Type DFS-21 Dual Keyer Frequency Shift Exciter comprises four types of circuits, viz: an exciter circuit, two frequency shift circuits, two keyer circuits, and a power supply and metering circuit, all combined to produce an R.F. output signal of up to 2 watts in the frequency range of 75 Kc/s to 375 Kc/s with single or dual frequency shifts of  $\pm 5$  cps to  $\pm 100$  cps, or at a constant output frequency, depending on the type of keying desired.

Since the desired output frequency,  $f_o$ , falls below all frequencies generated within the unit, undesired harmonics and spurious frequencies are suppressed by a low pass filter following the second mixer. The output frequency is subsequently passed through a driver stage and then to a tuned power amplifier output stage. Amplitude keying (A1 modulation) is obtained by on-off keying, at the driver stage, from either of the keying circuits.

**Frequency:** 75 to 375 Kc/s in four bands.

**Stability:** Fully crystal controlled,  $\pm 2$  cps nominal  $\pm 2$  cps at maximum shift, eight hours 0 to 50°C and primary variation of  $\pm 10\%$

**Frequency**

**Separation:** Adjustable continuously from 5 to 90 cps.

**Emission:** F1 dual or single channel, C.W. either channel. (A1)

**Power Output:** Adjustable, 0.1 watt to 2.0 watts.

**Output Impedance:** 50 or 75 ohms.

**Spurious Output:** 40 db below carrier, or better

**Deviation, single Channel:** Channel 1: Adjustable,  $\pm 5$  cps to  $\pm 50$  cps

Channel 2: Adjustable,  $\pm 10$  cps to  $\pm 90$  cps

**Keying Rate:** (1) to 1000 Dot P.P.S. on Frequency Shift

(2) to 50 Dot P.P.S. on C.W. either channel

### KEYING INPUT FACILITIES

a) **Contact Keying:**

Input impedance 50K ohms. Loop current 1.0 mA max. (line shorted for MARK keying)

b) **Voltage Keying:**

Voltage range 10 to 150V. Input impedance is 50 K  $\Omega$  for positive voltage, 100 K  $\Omega$  for negative voltage. Neutral and polar sense may be reversed by KEYING switch.

**Input Power:** 115 volts, 60 cps, 140 VA, nominal. Specifications apply over a voltage range of 105 to 125V. A.C.

**Dimensions:** Rack panel 10-1/2" x 19" (26.7 x 48.3 cm)

Chassis depth 14" (35.6 cm) maximum.

**Weight:** 36 lbs. (16.3 kg) unpackaged.

60 lbs. (27.2 kg) packaged.



**4-7-00000000**

OVER 1

OVER 2

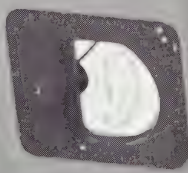
**DUAL KEYS**  
**FREQUENCY SHIFT EXCITER**  
75 TO 375 KC/S  
TYPE D.F.S. 21  
115V 60 CY 1.50 KVA.  
RECORD IN CANADA BY  
1-17000000  
1-17000000

1000 Hz

1000 Hz

1000 Hz

1000 Hz



## TWIN-SHIFT LF RECEIVER-DECODER

The type DFR-21A Twin-Shift receiver was developed by Topping Electronics to meet modern requirements for a highly selective, high sensitivity low frequency receiver, capable of reception and decoding of narrow shift Twin-Shift radioteletype signals. Designed for maximum operational simplicity, the equipment employs preset RF tuning. Crystal control of preset frequencies and a highly stable VFO for a second conversion results in excellent frequency stability, obviating requirements for automatic frequency control. The receive frequency is selected by a single four-position front panel switch, and a continuously variable fine frequency panel adjustment up to 50 cycles to permit "nose" tuning. Minimum noise response is ensured by full FM limiting and an additional noise pulse clipper. Neon mark space channel lamps provide visual tuning and operational indication. Sidetone output may be obtained from a jack for monitoring or CW purposes. Metering facilities are also provided.

The unit combines the functions of receiver detector and decoder, each of the four preset receive frequencies tuneable over the entire band of 75 to 225 Kc/s. Two independent telegraph outputs are provided, consisting of two unbalanced polar voltage signals. Output voltages are adjustable from ten to twenty volts into 47000 ohms for operation of error correction, storage, or other circuits. A novel type of frequency shift detector-decoder is employed which does not depend on amplitude responses of individually tuned circuits. This has minimum response to transient interference and also permits reasonable deviation of carrier frequency without appreciable degradation of telegraph signal outputs.

The exceptional selectivity of this receiver results from the development of special miniature low frequency intermediate frequency transformers operating at 28 Kc/s. Four stages of intermediate frequency amplification and selectivity are employed, providing 300 cycle 3 db bandwidth and 1500 cycle 80 db bandwidth. Noise pulse clipping at early stages of the intermediate frequency chain virtually eliminates IF ringing problems.

<i>Tuning:</i>	The receiver circuit employs four tuned RF circuits for each receive frequency, preset adjustments are by oven operated crystal replacement, actuation of a 3-position band selector, and peak tuning of four slug-adjusted coils. Alternate VFO input in lieu of crystal operation may be substituted.
<i>Frequency:</i>	Any one of four preset frequencies in the band 75 to 225 Kc/s, crystal controlled, switched.
<i>Sensitivity:</i>	Better than 0.2 microvolts for 10 db S+N to N, measured at limiter input, 3 db limiting at 2 microvolts input.
<i>Selectivity:</i>	3 db at $\pm 380$ cps: 60 db at $\pm 1000$ cps: 80 db at $\pm 1500$ cps.
<i>Image and Spurious:</i>	80 db rejection over band 80 to 220 Kc/s.
<i>Frequency Stability:</i>	$\pm 5$ cps for 10°C ambient temperature change plus $\pm 2$ cps over the range 0 to 40°C.
<i>Frequency Accuracy:</i>	Adjustable over a range of 50 cycles for any preset frequency, continuously variable front panel control.
<i>Noise Limiter:</i>	Impulse noise clipper provided in Intermediate frequency chain to limit noise plus transients 2 db (v) in excess of carrier. This is in addition to the 6 db balanced FM limiter circuit.
<i>Cross Modulation:</i>	Negligible for undesired signal not less than 1 Kc removed and 60 db in excess of desired signal.
<i>Antenna Input:</i>	75 ohms, unbalanced into an SO-239 connector.
<i>Output:</i>	Two independent telegraph outputs, polar, unbalanced, and internally adjustable from $\pm 10$ to $\pm 20$ volts peak into 47,000 $\Omega$ . A single multiplex tone output is also provided.
<i>Keying Rate:</i>	DC to 100 bands, either channel independently.
<i>Reception Mode:</i>	Dual Frequency Shift, frequency separation determined by replaceable plug-in filter, anywhere in the range 30 to 70 cps. (51.5 cps is recommended). Single Frequency Shift and CW signals may also be received.
<i>Distortion:</i>	10% Maximum telegraph distortion, either channel, at 51.5 cps shift for carrier frequency variations of 10 cps.
<i>Gain Controls:</i>	60 db of RF gain control may be obtained from either internal AGC or manual front panel control.
<i>Input Power:</i>	115 volts, 60 cps 140 VA nominal. Specifications apply over an input voltage range of 105 to 125 VAC.
<i>Dimensions:</i>	Panel 19" x 8 $\frac{3}{4}$ " (48.3 x 22.2 cm) Chassis Width 16 $\frac{1}{2}$ " max. (41.9 cm) Depth 17" overall (43.2 cm)
<i>Weight:</i>	39 lbs. (17.7 kg.)





## SINGLE SIDEBAND COMMUNICATIONS RECEIVERS

The Canadian Marconi Company's XH13A receiver system consists of four independent receivers plus a power unit and audio amplifier with built-in monitor speaker. Modular construction plus a range of models for AM, SSB or switched AM/SSB reception provide extreme flexibility of system design.

All solid-state design allows the installation of the four receivers and its associated power supply and monitor speaker in a panel area of only 8- $\frac{3}{4}$ " (22.2 cm) on a 19" (48.2 cm) rack. Transistorization also permits extremely low power consumption — 7 watts per receiver, average.

Five tuned circuits, ceramic IF filters and an electromechanical SSB filter provide outstanding selectivity. Optional meter reads signal or AF line levels. AF is available on phone jack and balanced line connection. IF-derived AGC maintains audio level over a signal range of 120 db.

Solid state power supplies, with complete voltage regulation, are available for 115 or 230 volts AC and 12 volts DC.

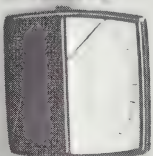
Specifications: Frequency range; 1.6 to 24 mc. RF channels; 1 per receiver module. Sensitivity: SSB — 1 microvolt for 12 db S+N/N. AM — 1 microvolt for 6 db S+N/N. Selectivity: SSB — 2.1 kc at less than 6 db down, 6 kc at more than 60 db down. AM — 6 kc at less than 6 db down, 30 kc at more than 60 db down.

The above electrical specifications are also available in Canadian Marconi Company's XH14 Receiver. Although identical in electrical design concept and operational facilities, the XH14 is presented as a completely self contained receiver module. As opposed to the XH13A system which operates up to four receiver modules from a common power supply/audio monitor unit, each XH14 module has its own power supply and audio facilities.

Two XH14 receivers may be mounted side by side on a standard 19" rack in 3 $\frac{1}{2}$ " of panel space (48.2 × 8.9 cm).

Both XH13A and XH14 receivers are provided with ample remote control facilities.

HF RECEIVER TYPE XH 13  
FREQ. MC

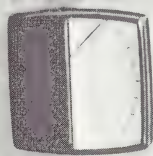


POWER  
RF GAIN  
AF GAIN  
PHONE  
RE T E R  
AF R  
A C C  
ON  
OFF

GREEN  
C. ANDERSON  
SSB  
AM

ADIAN MARCONI COMPANY

HF RECEIVER TYPE XH 13  
FREQ. MC

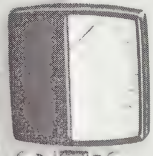


POWER  
RF GAIN  
AF GAIN  
PHONE  
RE T E R  
AF R  
A C C  
ON  
OFF

GREEN  
C. ANDERSON  
SSB  
AM

ADIAN MARCONI COMPANY

HF RECEIVER TYPE XH 13  
FREQ. MC



POWER  
RF GAIN  
AF GAIN  
PHONE  
RE T E R  
AF R  
A C C  
ON  
OFF

GREEN  
C. ANDERSON  
SSB  
AM

ADIAN MARCONI COMPANY

HF RECEIVER TYPE XH 13  
FREQ. MC



POWER  
RF GAIN  
AF GAIN  
PHONE  
RE T E R  
AF R  
A C C  
ON  
OFF

GREEN  
C. ANDERSON  
SSB  
AM

ADIAN MARCONI COMPANY

POWER SUPPLY CMC 193 550

MONITOR



RECEIVER  
VOLUME  
ON  
OFF

PRIMARY  
POWER  
ON  
OFF

ADIAN MARCONI COMPANY

## HF SINGLE SIDEBAND TRANSCEIVER & TRANSMITTER

The Canadian Marconi Company's CH25 transceiver is the first single sideband unit readily usable for mobile installation. Transistorized design has permitted a 100 watt PEP unit weighing less than 22 lbs (10 kg) in one compact package suitable for underdash mounting.

Six simplified controls perform all operating functions. The transmitter is monitored by automatic load control and the receiver by automatic gain control. These features, plus the outstanding frequency stability, ensure easy operation by non-technical personnel.

The compatible AM feature of the CH25 permits it to be used in conjunction with regular AM systems. A Constant Percentage clarifier control allows fine tuning of the receiver for best signal reception.

Designed to handle 1 to 6 channels, the use of plug-in channel elements permits rapid on-location changing of channel frequencies. An internal 1000 cps signal may be employed for testing or signalling.

The CH25 may operate on completely independent transmit and receive frequencies with a choice of upper or lower sideband. This unit is also adaptable to frequency-shift or CW keying systems.

Specifications: Frequency range: 1.6 to 15 mc. Channels: 1 to 6. Sensitivity: AM (6 db SINAD) 0.7 microvolts. SSB (12 db SINAD) 0.5 microvolts. Power output: 100 watts PEP (SSB or compatible AM). Power requirements: 115 or 230 VAC, 50-60 cycles — 15 to 180 VA. 12, 24 or 32 VDC, 0.15 to 16 A. Weight: 22 lbs (10 kg). Dimensions: 13- $\frac{3}{4}$ " x 10- $\frac{3}{4}$ " x 7" (35 x 27.3 x 17.8 cm.).

For those cases which require the use of an independent HF/SSB Transmitter, as opposed to a Transmitter/Receiver Unit, Canadian Marconi Company can supply the PH17 100W PEP Single Sideband Transmitter equipment.

This unit is identical in specification and physical dimensions to the CH25 but provides only the transmitting facility.

Such an arrangement would prove useful in the case of a full duplex installation where transmitter and receiver should operate simultaneously and independently.





## FM 2-WAY MOBILE RADIO

Designed to operate in the 148-174 mc range the Canadian Marconi Company DT75 is a compact, light-weight 2-way radio for simplified, one-unit underdash mounting. High efficiency circuitry permits sealed-case packaging without external heat sinks.

The Minit Miser, a combination of stabilized crystal and oscillator module, provides precision transmitter frequency control without heaters, extra battery drain or warm-up delay.

Amp Miser circuitry, activated by pressing the Squelch control in, permits monitoring with the least battery drain, allowing the unit to be left on indefinitely. In the Amp Miser position full transmission power is achieved in a fraction of a second. By pulling the Squelch control out a special condition is achieved for heavily loaded channels. This gives moderate battery drain, plus full transmission power in less than 30 thousandths of a second.

Vernier AFC, stabilized crystals plus automatic frequency control lock the receiver precisely to the incoming signal — minimizing distortion and ignition interference. Helical resonators give superior front-end selectivity, a first IF crystal filter provides improvement in inter-modulation interference protection.

Simplified modular construction, the receiver and transmitter are on individual printed circuit boards, permits simplified maintenance.

### SPECIFICATIONS

#### RECEIVER

Frequency Range: ..... 148 - 174 Mc.

RF Channels: ..... 1 to 6, in any 1 Mc.

Sensitivity: ..... (12db SINAD) 0.30  $\mu$ V.

Eia Selectivity: ..... ( $\pm$  30 Kc) -70 db.

Eia Modulation Acceptance: ..... 12 Kc.\*

Spurious & Image Rejection:

More than -90 db.

Eia Intermodulation: .... (SINAD) -60 db.

Frequency Stability:

(-30 to + 60°C)  $\pm$  0.0005%.

Squelch Sensitivity:

(For 80% output) 0.25  $\mu$ V.

AF Output:

(Less than 10% distortion) 2.5 Watts.

\*Wide-Band Model also available for 60 KC spacing.

Power requirements: (13.8VDC — 1 watt audio)

Amp miser on: 0.32 amp, Amp miser off, 2.06 amp.

Dimensions: 4" x 9-1/8" x 10" (10.2 x 23 x 25.4 cm).

Weight: 10 lbs. (4.5 kg).

#### TRANSMITTER

Frequency Range: ..... 148 - 174 Mc.

RF Channels: ..... 1 to 6, in any 1 Mc.

Power Output: ..... 25 Watts.

Modulation: .....  $\pm$  5 Kc.\*

Distortion: ..... Less than 4%

Frequency Multiplication: ..... 24

Frequency Stability: .... (-30 to + 60°C)

FCC Accepted Models: .....  $\pm$  0.0005%.

Dot and Export Models: .....  $\pm$  0.001%.

Spurious Emissions: ..... -65 db, or more.





## THE AN/GRC-103 RADIO RELAY EQUIPMENT

The AN/GRC-103 radio relay equipment, designed and manufactured by the Canadian Marconi Company is a light-weight, portable, general purpose radio relay set designed primarily for use in conjunction with pulse code modulation (pcm) multiplex equipment to transmit up to 24 voice channels. An optional Applique Unit permits its ready adaptation to operation with frequency division multiplex equipment. The radio relay set operates in the UHF frequency band and is intended for service in Military Tactical communications at the Command or Battalion Headquarters level and essential links between field switchboards. It will also find applications with Civil Defence and emergency service communications. The equipment is easily transportable by air, is designed for mounting in either a  $\frac{1}{4}$  ton (226.8 kg) jeep having a trailer or in a  $\frac{3}{4}$  ton (680.4 kg) truck. The individual units of the equipment are each of the size that is easily carried by one man. The equipment fully meets military environmental and construction specifications for this class.

The radio relay set uses a directional antenna system which is also easily transportable and can be rapidly erected and oriented. The whole system is designed for continuous operation with special design considerations providing practical features which ensure easy installation and simple operational procedures under difficult field conditions.

The AN/GRC-103, operating with normal antenna systems, will provide good performance over line-of-sight paths in excess of 50 miles (80.46 Km). The set has reserve power permitting satisfactory operation to a remarkable degree over paths containing obstructions. A system having two terminals and seven relay stations, operating over normal paths provides 'Via Trunk' quality of performance. Reliability analysis predicts a mean time to failure in excess of 3500 hours.

The AN/GRC-103 is fully transistorized (with the exception of the final r-f amplifiers) and operates in the 220 to 1,000 mc frequency range. The transmitter delivers 25 watts to the antenna in any of 1,560 r-f channels. These channels are selectable in 0.5 mc increments throughout the frequency range of the equipment. Other channel separations are available. The receiver and Transmitter each have removable r-f assemblies to cover 3 operating bands, 220 to 405 mc, 395 to 705 mc and 695 to 1,000 mc. Channel changing can be accomplished within 30 seconds. Band changing however, requires that the r-f assembly be changed and the antenna be altered. Band changing may be carried out within 5 minutes.

The equipment is normally employed with a corner reflector antenna or a high gain log periodic antenna. These, together with a light-weight portable mast are specifically designed for easy transportation and rapid erection. The log periodic or corner reflector antenna together with a 30 or 50 foot (9 or 15 meters) antenna support tower, can be erected within 15 minutes by one or two men. The antenna support tower is completely portable, the longest item is five feet (1.5 meters) in length to ensure simple stowage and easy transportation.

The equipment has two major units, the Transmitter and Receiver. Each of these units contains its own power supply, operating from 115 vac, 47 to 420 cps, or, optionally, from 24 vdc. Each of these units is contained in a case 8.5 inches high, 12 inches deep and 17.25 inches wide (21.59 cm x 30.48 cm x 43.81 cm) and each weighs approximately 60 pounds (27.2 kg). These cases are suitable for separate transportation; they may be mounted in a standard 19 inch (48.3 cm) relay rack, or may be stacked, one on top of the other. All controls, indicators and r-f connections are on the front panel, while all other cable connections are to recessed receptacles in the rear of the units. The units have been designed for field use. The individual units are moisture resistant, and have been designed to operate over a very wide range of temperature and environmental conditions.

Each major unit has three replaceable r-f heads, each covering one of the frequency bands 220 to 405; 395 to 705, or 695 to 1,000 mc. The r-f heads are of plug-in form and are easily replaced from the front of the equipment and contain frequency sensitive r-f components together with frequency selection circuitry.

In addition to the two major units of equipment, two ancillary units, the Order Wire Unit and the FDM Applique Unit are available. Each is in a case 3.5 inches high, 12 inches deep, and 8.56 inches wide (8.9 cm x 30.5 cm x 21.7 cm) and each weighs less than 8 pounds (3.6 kg).





## TELEPHONE & TELEGRAPH FDM MULTIPLEX TERMINAL

Radio Engineering Products have developed and produced this militarized multiplex terminal which provides 1 order-wire channel, 4 telephone message channels, and 4 voice-frequency telegraph channels on a 4 or 2-wire line or radio circuit. The transmission band is 0.3 to 19.7 kc/s. The terminal includes hybrids with 2/4-wire switching, signalling converters and compandors on the telephone channels, test and line-up facilities, automatic transmission regulator, operator's telephone set, carrier hybrid for 2-wire line operation, and line equalizer. It requires only 6.4 watts of power at 12/24 volts dc or 10 watts at 115/230 volts ac 50, 60 or 400 cps.

The terminal is immersion-proof and meets all requirements for operation under tactical military environmental conditions. It weighs 31 lb (14.1 kg) or less, depending on the options chosen, and has a volume of 0.33 cu. ft. (9400 cc). The average period of trouble-free operation under conditions of tactical operation is presently measured in years.

The stability of transmission performance, with variations in temperatures, humidity, line voltage and aging, surpasses that of any previously available equipment.

Telephone loops may be switched either 2 or 4 wire. In the 2-wire position a high-accuracy compressor-expander and a 20/1600 cps signalling circuit are connected in each telephone channel. The compandor reduces a total volume range of 50 db at the transmitting terminal to a total range of 25 db in the transmission path, and at the receiving terminal this is expanded again to 50 db. A large reduction in noise, of the order of 20 db, is obtained.

The order-wire channel has a bandwidth of 0.3 to 2.8 kc/s, and includes an operator's telephone set, 20/1600 cps signalling converter, compandor, and hybrid circuit. It can be extended to the switchboard on a 2-wire basis. It permits signalling and talking to all attended points in the multiplex system and to the switchboards and also monitoring of the four telephone message channels and the four vf telegraph channels. The operator signals over the order-wire channel to the operator at the remote multiplex terminal at 1600 cps and over a local loop, if connected, at 20 cps.

Four vf fs 100-wpm telegraph channels are provided. Loops are 2-wire full-duplex. A miniaturized solid-state dc to ac converter is used at each teletypewriter; this converter also provides the loop currents. When the telegraph channels are not in use, the frequency band they occupy, from 3.045 to 3.755 kc/s, is available on a 4-wire basis for data or other applications.

When two terminals are connected by a line consisting of loaded spiral-four cable the maximum distance between terminals is approximately 45 mi (72 km). Two-wire operation over open wire (100 lb, (45.4 kg), 0.080 in, (2.0 mm) dia. copper) is satisfactory for approximately 160 km. (100 mi) when the telegraph channels are operated simplex. If duplex telegraph operation is required this distance is reduced to approximately 48 km (30 mi). Two-wire operation over field wire is satisfactory for distances up to 10 mi (16 km).

The reduction brought about by the channel compandors, of crosstalk and noise introduced in the radio or wire path between the multiplex terminals permits multiplex operation over radio sets such as the AN/VRC-12 or AN/PRC-25 which have ordinarily been used for a single voice circuit only. A 4 kc/s automatic regulator holds the channel vf receive levels within 0.5 db for changes in attenuation between the two multiplex terminals of as much as 50 db, and visual and audible alarms are given for a greater change. These features improve transmission by such a large factor that on long vhf radio systems the performance of each of the five multiplex channels is generally superior to that of a single voice circuit operating over the radio system.

The technical characteristics given are those of only one version of the standard equipment which is being produced. Optional arrangements include all usual frequency allocations and signalling frequencies.

A wide range of field communications equipments is available for use with this multiplex terminal. These include the following:

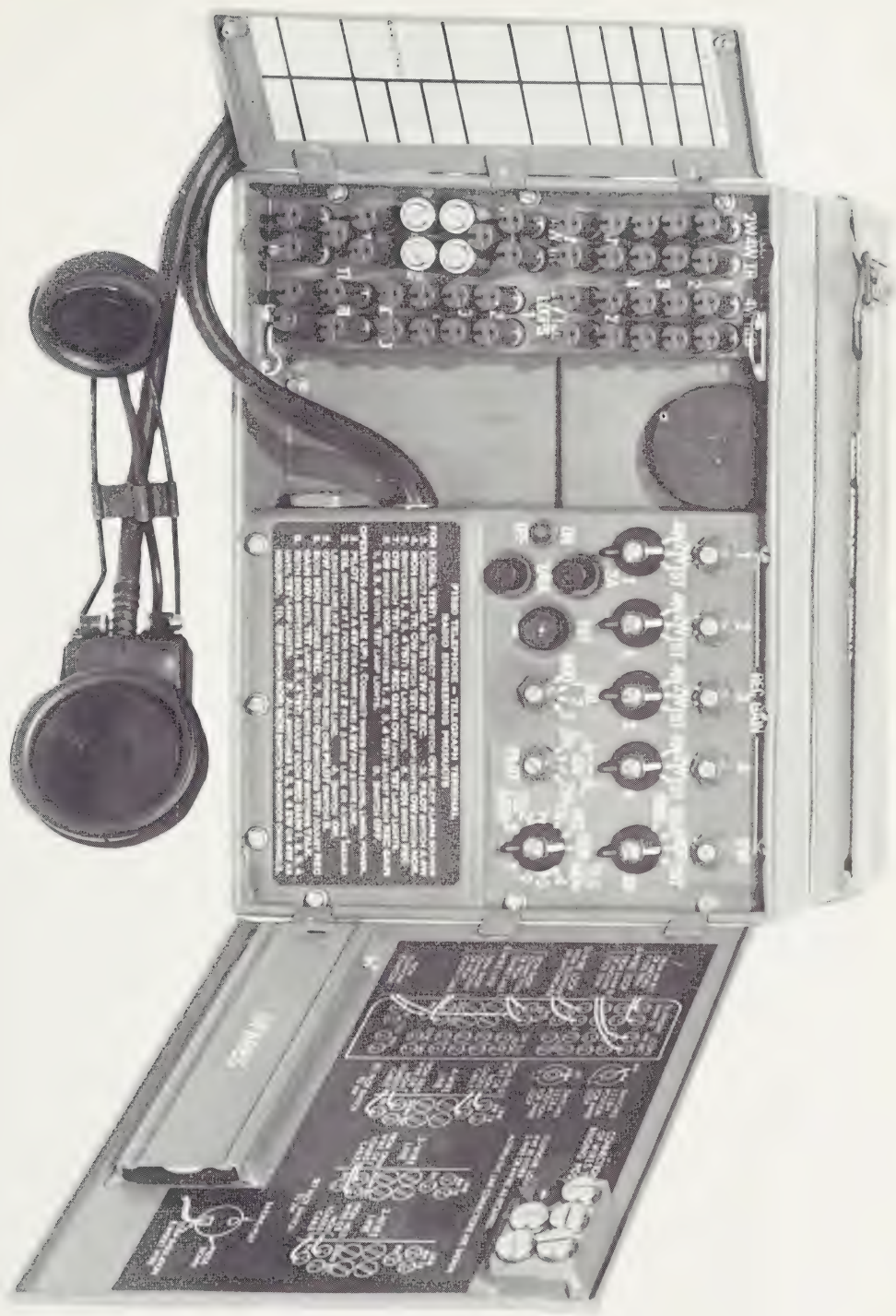
- Group Modems to form 3 plus 12 plus 12 channel terminal and 5 plus 24 plus 20 channel terminals.

- Converter for operational over long open-wire circuits.

- Lightweight Field Switchboards of 12, 24 and 36 line capacity.

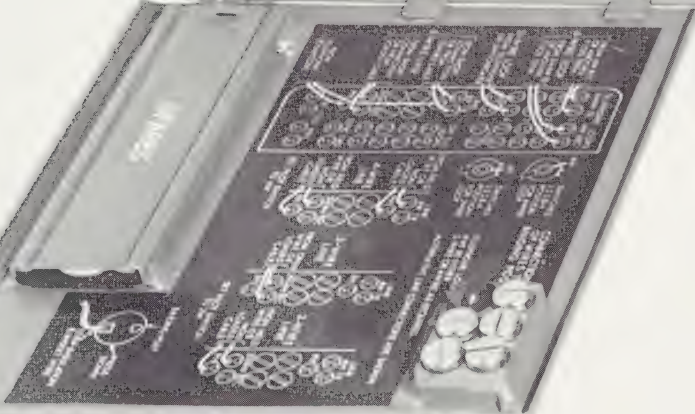
- Telegraph Converter for use at teleprinters utilizing 2 wire vf fs full-duplex loops.





**PORTABLE RADIO PHONE - TELEGRAPH UNIT**

FROM LOCAL, 1500 W. 1st Street, Los Angeles, California 100  
1. Complete assembly, including all accessories, in a carrying case.  
2. Operates on 110 V. AC, 60 cycles per second.  
3. Operates on 110 V. AC, 60 cycles per second.  
4. Operates on 110 V. AC, 60 cycles per second.  
5. Operates on 110 V. AC, 60 cycles per second.  
6. Operates on 110 V. AC, 60 cycles per second.  
7. Operates on 110 V. AC, 60 cycles per second.  
8. Operates on 110 V. AC, 60 cycles per second.  
9. Operates on 110 V. AC, 60 cycles per second.  
10. Operates on 110 V. AC, 60 cycles per second.



## SCIENTIFIC SATELLITES & SATELLITE SUBSYSTEMS

RCA Victor Company, Ltd., Montreal, as management contractor for International Satellite for Ionospheric Studies (ISIS) program, has designed, in the course of its work on the Alouette I, Alouette II and ISIS "A" ionospheric satellites, a series of equipments which can find application, with slight modification, in other international space programs. The aerospace business is such that each spacecraft requires its own "custom" equipment; however, the equipment is usually slightly modified versions of a few generic types.

Units and equipments developed by Space Systems of RCA Victor, and which could be used in other space projects, are:

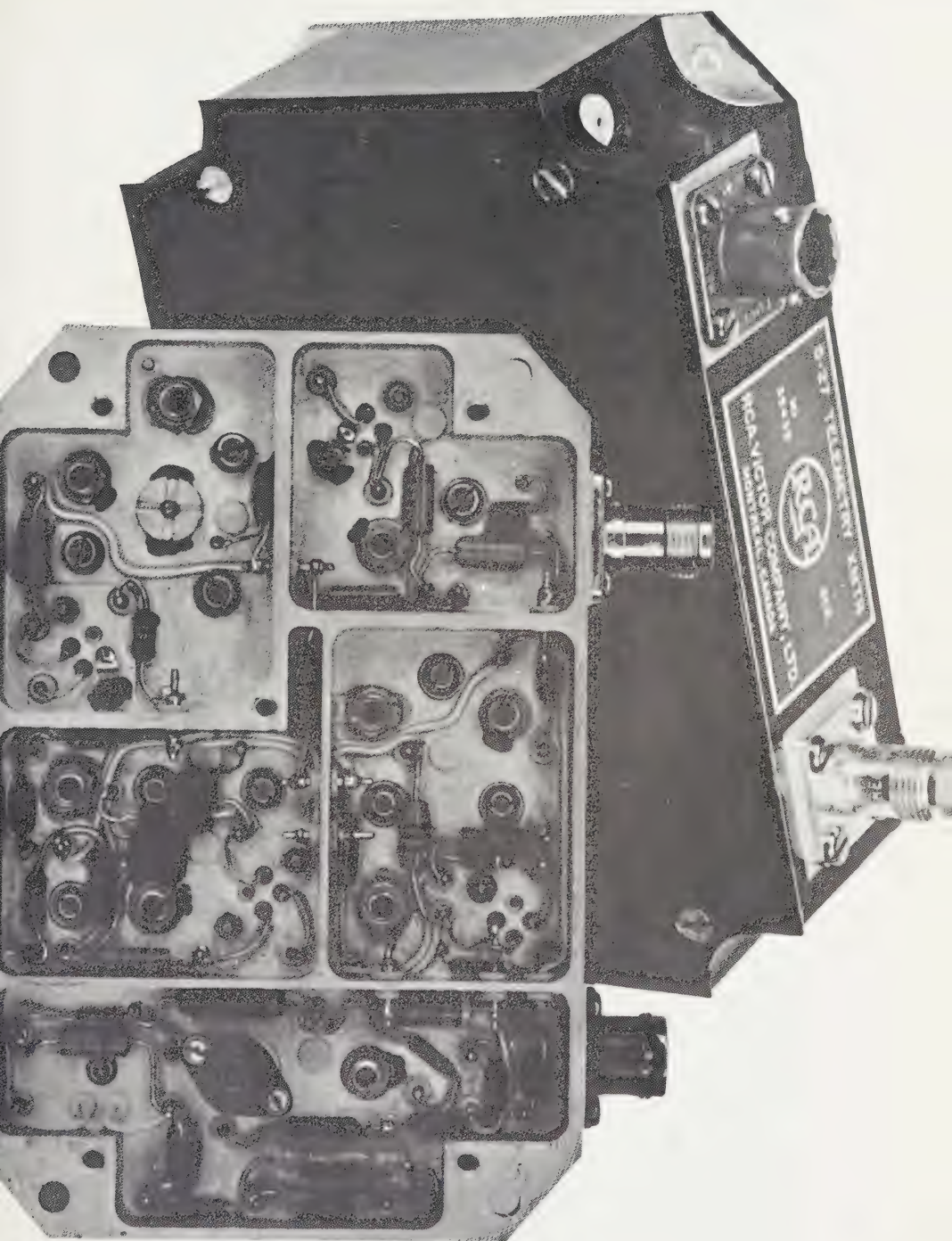
1. F.M. Telemetry Transmitters: 4 watts R.F. output at 136 Mc/s with true F.M. Modulation, d.c. to 50 Kc/s, and d.c. to r.f. power efficiency of close to 50% and weighing 1 lb. (.45 Kg.)
2. P.M. Telemetry Transmitters: 2 watts or 4 watts output at 136 Mc/s and weight of 1.25 lbs. (.58 Kg.)
3. Tracking Beacon Transmitters: 100 milliwatts R.F. output at 136 Mc/s and weighing 0.4 lbs. (.18 Kg.)
4. F.M. and P.M. Telemetry Transmitters: 4 watts R.F. output at 400 Mc/s and weight of 1.5 lbs. (.68 Kg.)
5. Duplexers and Duplexers: strip line designs for operation in the 136 Mc/s and 400 Mc/s telemetry bands and 123 Mc/s and 148 Mc/s command frequency bands. These units have characteristics far superior (in excess of 20 dbs) to anything available on the market.
6. Antennas: Turnstile, whip, quadrupole and annular slot antennas for operation at 123 Mc/s, 136 Mc/s, 148 Mc/s, and 400 Mc/s spacecraft assigned frequencies.
7. Pulse Code Modulation Encoders for encoding analog, serial and parallel digital.
8. Digital and Signals Analog Commutators.  
Combinations of items 7. and 8. could be used to sample (time division multiplex) a large number of digital or analog signals and convert to a single pulse code modulated output.
9. Digital Clocks (time generators).
10. Magnetic Stores.
11. DC to DC Converters: high reliability converters with conversion efficiencies up to 80% at 25 watts output and weighing 1.5 lbs. (.68 Kg)
12. Low — level Magnetic Amplifiers.

Detailed specification data sheets on the above units are available from RCA Victor in Montreal.

In the satellite environment, RCA Victor has furnished equipment for the following satellite programs:

RELAY I	Beacon, wideband transponder, sat. simulator
RELAY II	Beacon, wideband transponder, sat. simulator
Alouette I	FM telemetry transmitter
Alouette II	Manufacture of most of subsystems
Explorer S-48	FM telemetry transmitter
Pegasus (Micrometeoroid)	FM telemetry transmitter
ISIS "A"	systems management contractor







## H.F. SOUNDING SYSTEM

Long distance radio communication is dependent upon the ability of the Ionosphere to reflect the transmitted signal. To be able to guarantee communication between two stations at all times, a close watch must be kept on the reflecting properties of the Ionosphere so that the frequency giving optimum reflection can be selected for use. The Ionospheric measuring equipment was manufactured under Navy contract according to the requirements of 'Oblique Ionospheric Sounding System Standard' issued by the United States Defence Communication Agency and is only one of many complex equipments researched, designed, engineered and produced by EMI-Cossor Electronics.

The Transmitter produces a binary-coded pulse train of 30KW p.e.p., 1, 2 or 3 milli-seconds long. Frequency coverage is from 2 Mc/s to 32 Mc/s in four octave bands, each octave having twenty spot frequencies linearly distributed. The pulse train consists of 100 micro-second pulses, each having a Gaussian profile. Ten, twenty or thirty pulses are used according to the pulse-train length, and the pulses are phase-reversal modulated. A train of thirty pulses at 30 KW gives a receiver signal, using pulse addition, equivalent to a single pulse transmitted at 900KW p.e.p., while the binary code enables the signal to be identified.

The Receiver sweeps through the eighty frequencies in synchronism with the transmitter. This is achieved by using highly stable oscillator and timing units, and by further synchronizing both units to time standard signals.

One receiver is capable of operation with any number of transmitters up to a maximum of ten. When a transmitted pulse train is received it is demodulated to provide a binary code, and the separate code elements are added to provide a signal pulse to the display.

Using the pulse-compression technique the power gain by a 30-bit pulse train over a single pulse is 14.8db, while retaining the resolution of a single pulse. The receiver display provides instantaneous information on the state of the Ionosphere as an Ionogram on a c.r.t. display. The Ionogram has an *X* axis of frequency from 2 Mc/s to 32 Mc/s in eighty steps, and a *Y* axis of elapsed time. The reflection from the Ionosphere modulates the *Z* axis to provide a bright-up signal. The low weight and minimal power consumption of the receiver means that it may be fitted into any truck, ship or aircraft having sufficient space.

A Paper Recorder connected to the receiver provides a continuous reference to past conditions. The paper record has eighty channels, one for each frequency, arranged across the paper at sixteen channels to the inch. Elapsed time is recorded along the length of the paper at the rate of one inch per hour, with unique marks at noon and midnight. Each channel records a signal received as a mark on the paper, so that the paper record does not give detailed information, just the fact that a signal was received on a particular frequency at a specified time.

A specially designed, rugged Camera uses standard 100 ft 35 mm daylight-loading spools of film to automatically record Ionograms. The camera has a Wollensak f 1.9 to f 22 Raptar lens, and a flat-field non-distorting optical system. A data chamber provides three types of data: time, date, and exposure number.

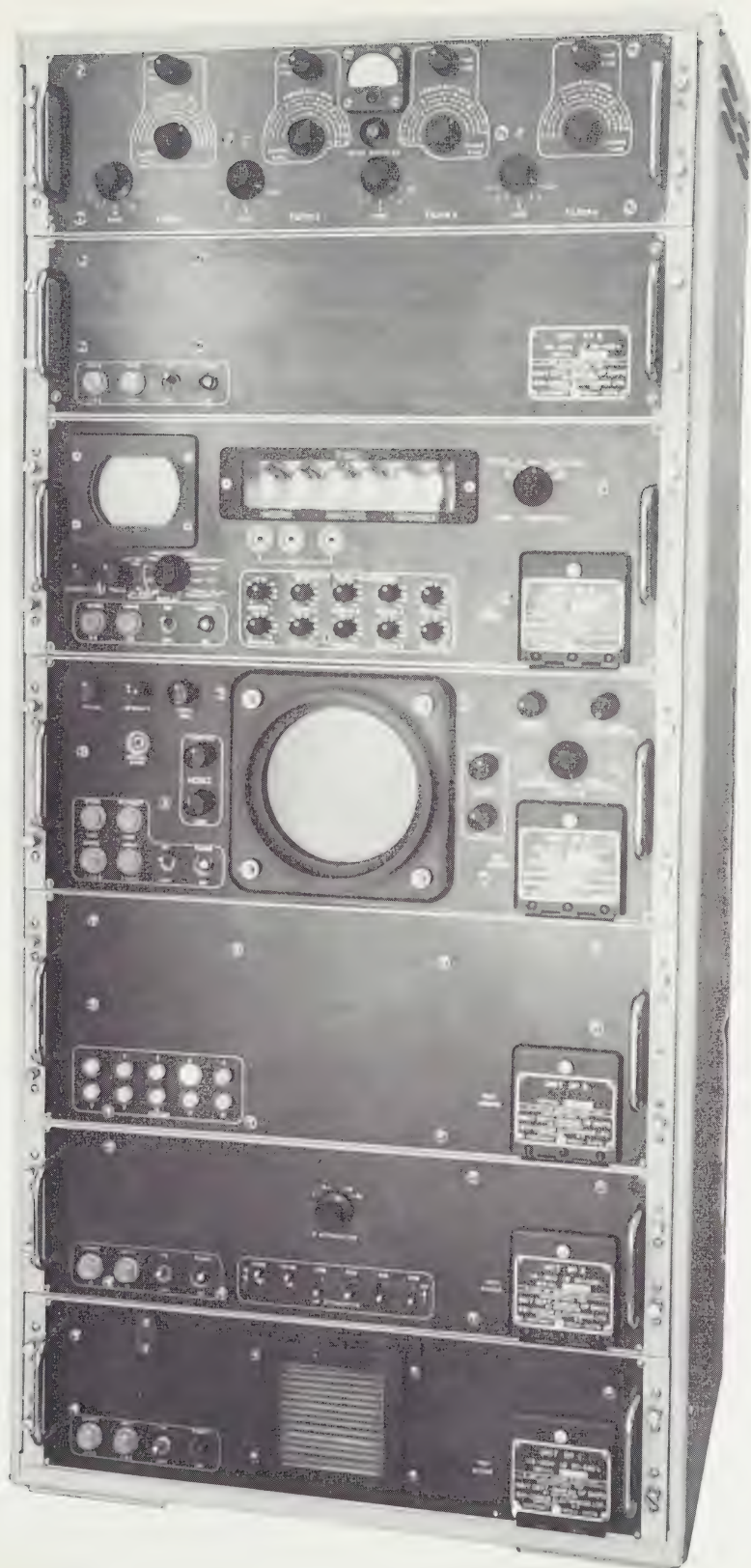
The Remote Display c.r.t. provides an Ionogram similar to the one shown at the receiver unit. Either of these Ionograms may be photographed by using the special camera. It should be noted that a photographic record provides complete information concerning a signal, i.e. frequencies reflected, number of hops, etc.

### TRANSMITTER

<i>Frequency response:</i>	Output power within 1 db below and 2 db above nominal.
<i>Output power:</i>	30 KW p.e.p.
<i>Duty cycle:</i>	6 per cent max.
<i>PRF:</i>	20 pulse trains per second.
<i>Pulse train:</i>	2 at each frequency per transmission cycle, each consisting of 10, 20 or 30 pulses.
<i>Pulses:</i>	100 $\mu$ Sec. duration, phase reversal modulated, Gaussian profile.
<i>Stability:</i>	One part in $10^9$ per day.
<i>Accuracy:</i>	One part in $10^6$ .
<i>Power Supply variation:</i>	10 per cent change causes less than one part in $10^9$ frequency change.
<i>Spurious and harmonic levels:</i>	50 db minimum below the output signal level.
RECEIVER	
<i>Sensitivity:</i>	$3 \mu V$ for $\frac{S+N}{N}$ ratio of 20 db.
<i>Overload recovery time:</i>	Less than 500 $\mu$ Sec.
<i>Selectivity—</i>	
<i>adjacent channel rejection:</i>	20 db minimum
<i>beyond adjacent channel rejection:</i>	60 db minimum

### POWER SUPPLIES REQUIRED

<i>Transmitter:</i>	208V 3 phase 50 or 60 c/s.
<i>Receiver:</i>	115V or 120V at 2 amps single phase 50 to 400 c/s.
<i>Frequency coverage:</i>	2 Mc/s to 32 Mc/s by eighty spot frequencies.



## AIRBORNE DIGITAL COMPUTER — AN/UYK-501

Of particular significance is the general purpose digital computer, designated AN/UYK-501, designed and developed by Computing Devices of Canada Limited.

It incorporates three features offering distinct advantages: microprogramming, fast interrupt and modular expansibility.

The advanced microprogramming concept of the UYK-501 provides a large variety of commands, giving a total of 110 major commands. Special commands in the repertoire have been based on practical experience of integrating this computer into specific military systems.

Fast interrupt is achieved on 64 independent levels, each with eight working registers without incurring a software penalty. When an interrupt occurs, control is switched to the appropriate set of registers allowing the new program to be executed immediately. Control reverts to the previous set of working registers, with no time lost in switching from one program level to another.

Modular design allows expansion of both arithmetic and memory capacity, and intertalk between the arithmetical and memory units, offering extremely high computing and data handling capability at low cost.

Operating speeds: addition and subtraction, 8 microseconds; multiplication 110, division 118 microseconds. Memory access time, 1 microsecond, read-write cycle 2 microseconds; capacity 4096 words (25 bits), expandable to 32,768 words. Average input/output data handling rate is 135,000 words per second.

Computer units are housed in short ½ ATR box which measures 4.875 inches (12.38 cm) x 7.625 inches (19.37 cm) x 12.56 inches (31.9 cm); volume approx. 470 cubic in. (7690 cc). Individual weights are: arithmetic unit, 18.2 lbs (8.26 kg), memory unit 20.2 lbs (9.26 kg). A mounting rack to hold the basic computer plus two extension memories weighs approximately 22 lbs (9.98 kg).

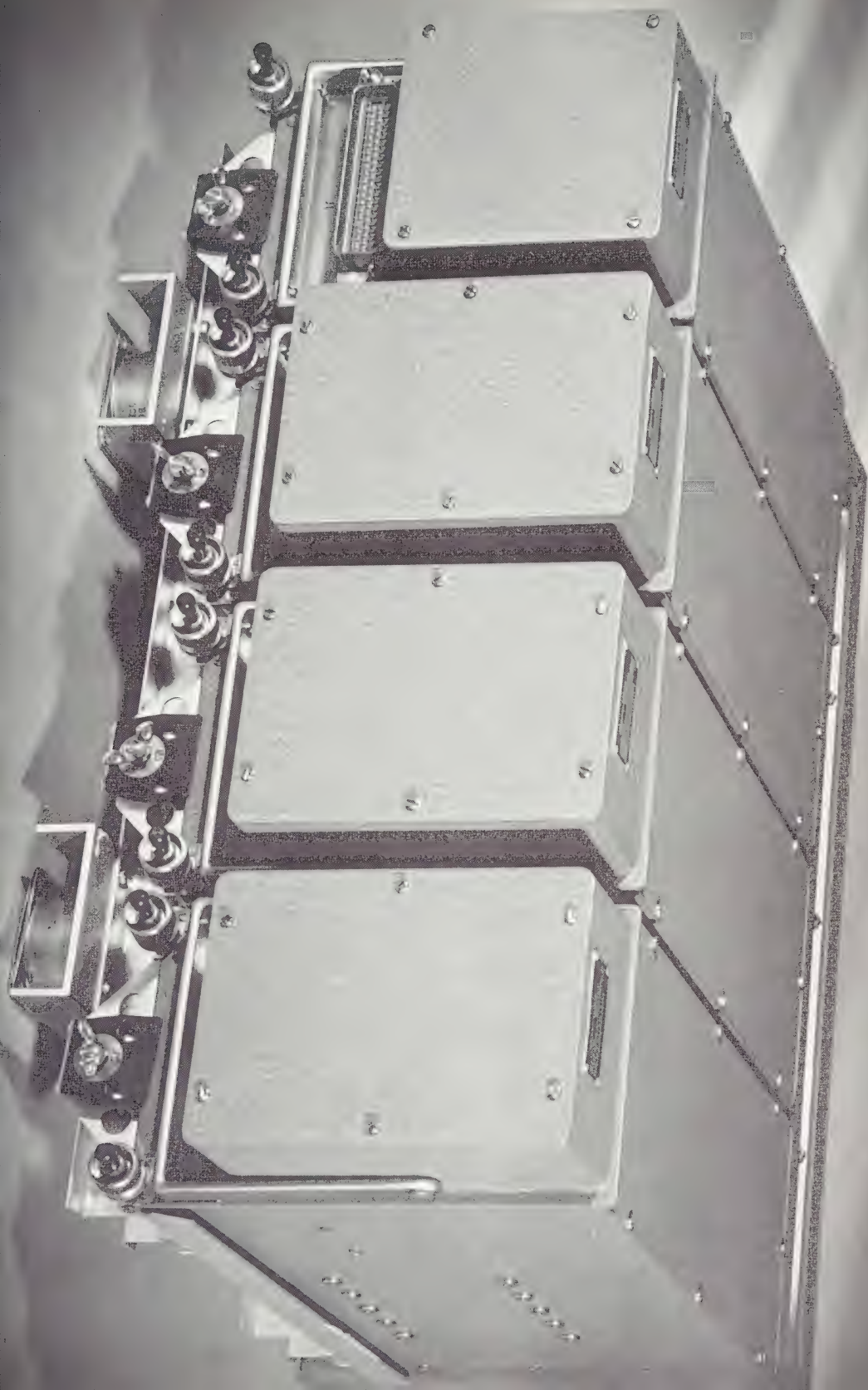
The computer will operate from external supplies of 115 volts, 400 cycle, 3-phase, or 24 volts DC. Total power consumption for the basic computer is 240 watts (mean); this will increase by 42 watts with each extension memory unit added.

The computer has been interfaced with a number of standard peripheral units: typewriters, punched cards, paper tape readers and punches, and high speed line printers.

Test equipment includes a circuit card test set, used with a programmed test tape to locate any fault on an individual circuit card; and a computer test set, which is used with diagnostic test programs to locate and identify faults within the computer. The test set also provides the means for loading and displaying the contents of the computer registers and memory locations.

Systems have already been delivered to the United States Department of Defence and other computers now being produced have been sold in Canada and abroad.





## DETECTING SET, RADAR "MICRADET"

"Micradet" designed and produced by Electronics and Defence Products Department of Canadian General Electric detects and localizes pulse modulated microwave sources such as radar and jamming transmitters within the normal direct line of sight limitations.

Receiver is a crystal video type, operating on a frequency coverage of 2 to 40 Gc/s. It has three parallel antennas, two horns and one spiral. The range of the receiver is a function of the illuminated radar. Under line of sight conditions, the receiver can detect radar AN/PPS-4 at ranges in excess of 10,000 meters. At extreme ranges, the "Field of View" varies from approximately 1600 mils ( $90^\circ$ ) at the low end of the frequency range, to about 500 mils ( $28^\circ$ ) at 40 Gc/s. The signal indication is by audio tone in the head set. The head set is a single earphone with detachable frame and flexible twin cord. This model has a count down feature to allow operator detection of high prf radars.

The unit is small, hand carried, and fits easily into the pocket when not in use. The shelf life of the basic equipment is indefinite while battery shelf life is given as five (5) years. Working life for the basic equipment is indefinite and unit field servicing is possible without recourse to special tools. Battery working life is twelve (12) hours.

"Micradet" was produced using Canadian Army CA-G100 as the basic list specification thus ensuring a rugged and waterproof equipment.

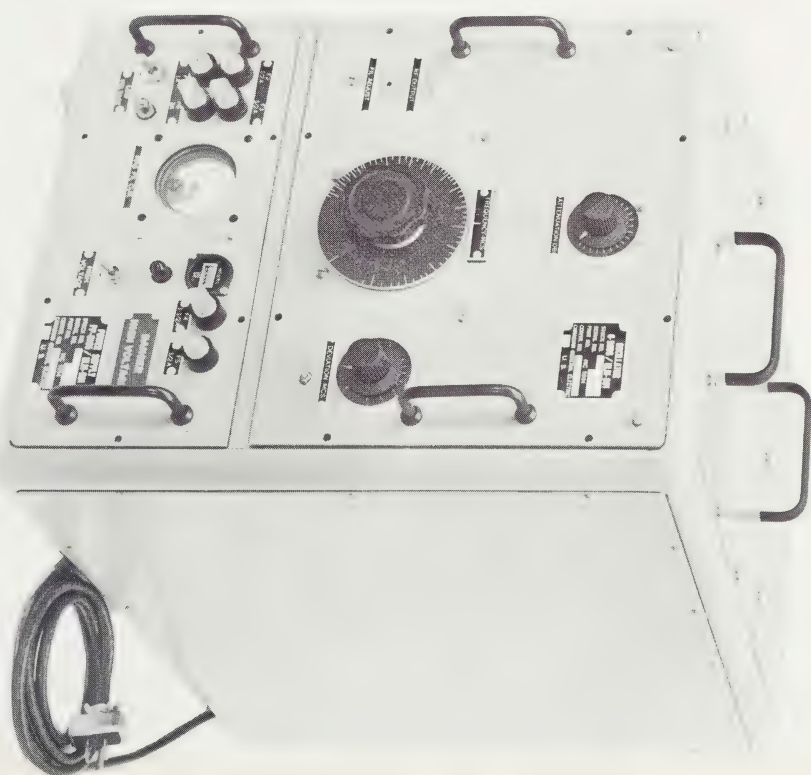
CGE having maintained an Active Research & Development organization has a most impressive group of equipments which they have developed and produced for either the U.S. or Canadian forces. This group includes: AN/FPS-24 Oscillator-Driver; AN/FRC-47 Intermediate Power Amplifier; Radar Sets AN/FPS6, AN/FPS-507, AN/APG-30 and AN/APG-501; AN/ASG-501 Armament Control System and associated Ground Support Equipment; Radio Sets AN/PRC-502 & AN/PRC-503 as well as the AN/ULM-501 Countermeasures Signals Simulator.

This same facility has also produced the AM Radiotelephone Type CRC/FRT-1006; 50 Watt VHF Transmitter Type CRC/CTC-04; 1 Kilowatt VHF Transmitter Type CG6601 and Radar Video Integrator Type CRC-RVE-01 equipments for the Department of Transport, Canada.

The Countermeasures Signals Simulator AN/ULM-501 is a portable test set which generates an output signal of the swept jamming type and is currently in operational use with the USAF and RCAF. The Simulator's output, which covers a wide frequency range, is a microwave cw signal, frequency modulated by noise. The Simulator is used for determining and evaluating the ECCM performance of Radar Receiving Systems that are designed to combat frequency modulated by noise signal jamming. This equipment was designed by Canadian Arsenals and was further developed, production-engineered and manufactured by the Electronic and Defence Products Department of Canadian General Electric.

In the commercial market, Canadian General Electric has developed and/or manufactured products in the following categories: radio and television broadcast equipment, mobile radio communication equipment, medical electronics equipment, industrial analog computer equipment.

Current applied research activity is in the broad field of signal processing with considerable emphasis on defence problems in radar and sonar systems. A market capability exists in the electronic warfare field resulting from several contracts received from U.S. and Canadian defence agencies.





## PRINTED CIRCUIT BOARDS & EDGE-LIGHTED PANELS

The exacting demands on to-day's technology in such fields as supersonic Aircraft and Aerospace vehicles are producing not only a range of new equipments to futuristic requirements but also facilities which will design, develop, and produce these equipments to to-morrow's standards.

O. & W. Electronics Limited is one of those sources which has been active in the Aerospace field for over fifteen years and which has clearly demonstrated a leading role in Printed Circuitry and Edge-Lighted panels.

Applications range from the Automotive field with flexible mylar printed circuit boards to the rigid boards and panels used in radio and television sets, mobile radio, aircraft radio and instruments as well as in space satellite applications. The Boards are produced from a variety of materials which include single and double sided copper paper-based phenolics, glass epoxies, glass melamines, flexible mylars, etc. From these materials both single and double sided printed circuit boards with or without plated-through holes are produced together with flush bonded circuits for commutator or switch applications.

A variety of finishes are available such as flux-cote, melamine solder resist, nickel-gold, tin-nickel, silver, rhodium and tin-lead with the latter five finishes being electro-plated. These Boards are produced in accordance with MIL-P-55110A and related specifications.

O. & W. Electronics have supplied Printed Circuits for the F-104 programme, the VRC12 and Autodin communication equipments as well as car radio boards for Philco and "flexible instrument cluster boards" for the Falcon and F85 Oldsmobile.

Edge-Lighted panels are designed and produced to the latest revision of MIL-P-7788. The Lackon process is employed in the photo marking of panels giving sharper detail and accuracy of graduations or markings to .001" and angular tolerances of 5' of arc. The process will register in black and white or colour. Certificates of approval from both United States and Canadian military authorities are held covering the quality assurance of both Boards and Panels.

O. & W. Edge-Lighted panels may be found throughout the following aircraft; CL-44, CL-41, F104, F5, F-4 (Phantom), Caribou, Buffalo, Twin Otter and such equipments as the ASN30 Navigation Set in the Grumman.

This same production source maintains the following "in-house" facilities so as to ensure the high quality and reliability demanded of such equipment:

- Engineering: engineering assistance is available to help solve any illumination layout or functional problems which might arise during the design stages.
- Art Department: to work from customer blueprints and specifications to make the necessary photographic master.
- Machine Shop: to maintain the consistent quality of panels, dials and scales.
- Processing and Inspection: over and above the normal to be expected equipment is a Light Laboratory. A DND Inspector is also in residence.

This same facility also produces a wide range of photo-processed custom metal panels, scales and dials for electronic equipment as well as chemically milled parts. Naturally the assembly of hardware to Boards as well as the assembly of electronic circuitry is standard work to custom requirements.

O. & W. Electronics have substantial export markets to such highly technical and competitive areas as U.S.A., England, Holland, West Germany, Italy and Japan.





## GAS LASER DEVELOPMENTS

The National Research Council, as a natural function in the Canadian research and development field, commenced work on Lasers in early 1960. The existence of the instruments discussed in this article is largely due to the work carried out by the Interferometric Section of the Council. Another of the basic functions of NRC is to further ensure that a practical and capable source, in Canadian industry, is found for product development and manufacture.

The participation of Ernst Leitz Canada Limited in this programme, which encompassed development, product engineering and production, has a natural background in the following points:

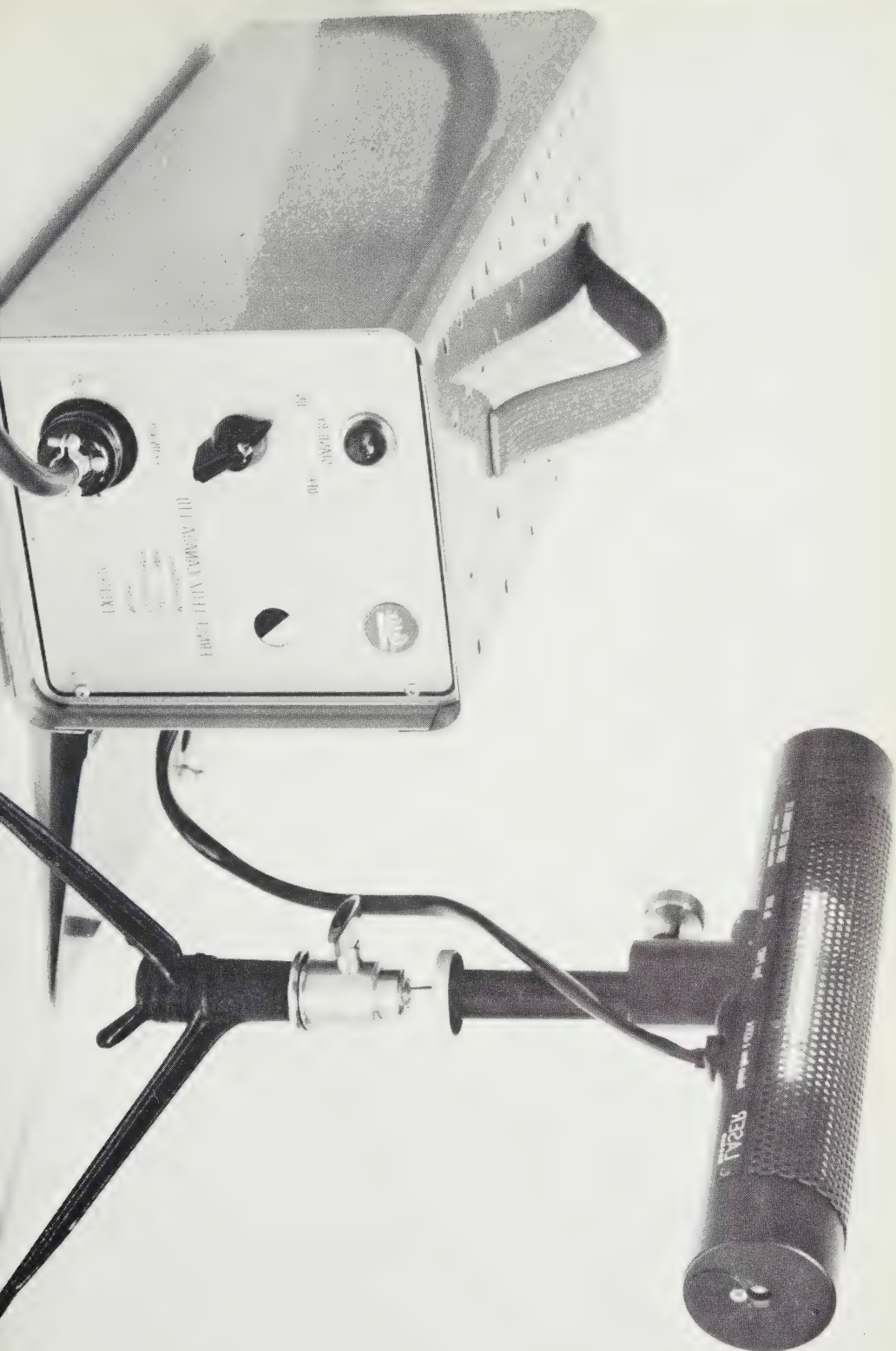
- (a) Manufacturing at Ernst Leitz involving optical and fine mechanical instruments, continually demands precision of the highest calibre in production and quality control.
- (b) The normal product line of the company is an ideal base for which the Laser can serve as an accessory.
- (c) The equipment of the Plant is ideally designed and the personnel have the necessary background for the further development and manufacture of Lasers.

In the field of light sources Gas Lasers are revolutionary, for as known, they emit truly monochromatic light to the highest degree of coherence. This fact has led to the development of the Canadian instrument for a number of practical applications:

- Before the development of Gas Lasers conventional monochromatic light sources had a relatively short length of coherence. This imposed great restrictions to interferometric measurements, in fact, some were even impossible. The Gas Laser has now obviated these restrictions for true coherence is now obtainable over many miles. It is expected that the Gas Laser will become a standard light source for interferometers.
- As it is possible to produce a single-line frequency in a stabilized manner, the Gas Laser has also found application in metrology.
- In physical optics, where it was hitherto impossible to demonstrate many phenomena, the Laser beam is a tool to broaden the understanding of optics and thereby broaden the education and background of our future scientists by now physically portraying these phenomena. At the same time the properties of geometrical optics can now be clearly demonstrated to the students of science, engineering, etc., by the employ of this new instrument in a classroom role.
- Active research will continue in the telecommunication field to ensure that the Laser leaves the laboratory at the earliest possible moment and becomes a practical device.
- In aircraft manufacture, the manufacture and erection of massive but precise mechanical equipment, ship building and turbine installations, difficult alignments are a normal requirement. To telescopes and collimators, which have been the primary tools for precision alignments, the Laser has now been added and opens up new possibilities in this field.
- Present development of Lasers would indicate that security measures devices will see an increase in range and a decrease in bulk of equipment over presently employed mechanical or electrical mechanisms.

The picture on the facing page depicts the Leitz Helium-Neon Gas Laser which emits light at  $6,328 \text{ \AA}$ .





## ELECTRONIC SIGNAL PROCESSING RESEARCH PROGRAM

Canadian General Electric has engaged in a wide variety of design, development and manufacture of military electronic equipment since 1945. In late 1962, this company initiated a major program of applied research in the field of Electronic Signal Processing. The program, to be fully established during a five year period, is jointly sponsored by the Defence Research Board of the Department of National Defence and Canadian General Electric.

The objective of the program is to undertake studies to improve the performance of electric systems and, specifically, to pursue a long term program relating the latest information theory to the design of optimum pulse codes (waveform design). The long term objective is to maximize the information received by given radar or similar obstacle location systems in non-ideal environments (clutter).

The research relates to systems working in space, atmospheric and undersea media, and the theoretical solutions obtained from the research are verified on a special computer involving a general coded matched filter which has been designed and fabricated as part of the program. The information derived is not only applicable to new or future designs but is also used to design "black box" retrofit modifications to enhance the signal processing capability of existing radar and sonar equipment. Specific research activities are as follows:

*Systems Analysis* This involves the application of information theory, filter theory and waveform design to signal processing problems; studies of coded waveform implementation techniques in both unclassified and classified programs and studies in obstacle location systems as foreseen for existing and future environments. *Non-Ideal Environments* Analyses and experimental studies employing a general coded matched filter are made on the effects of non-ideal environments on waveform design and application as, for example, the effects of non-ideal transmission media; to assess and recommend the suitability of specific classes of waveforms (different forms of codes) and system concepts operating under such conditions. *Synthesis* Modern methods of applied mathematics are used in conjunction with information from the studies outlined above to investigate and design waveforms or classes of waveforms which are particularly applicable to such special situations, thus providing guidelines for experimental testing. *Experimental Techniques* Experimental equipment with which the synthesis activity can be supplemented has been constructed and results experimentally verified. This involves general coded matched filters using analog and digital techniques. Digital computer programming and electro-optical systems are also used for simulation. *Related Antenna Studies* Inherent in the optimization of radar, communication and sonar signal processing systems and the application of coded waveforms, is the requirement for radically new approaches to antenna and transducer configurations (phased arrays, synthetic apertures, etc.). As the design of the waveform generation equipment and the optimum radiating structure is inseparable, antenna theory studies are pursued in parallel with the activity outlined above.

The research program as outlined above is not only directed at improving existing systems, but at increasing skills to meet the requirements of the future technology.

In recent years, Canadian General Electric has considerably expanded its military research and development program. In 1964, it was selected by the Canadian Department of Defence Production to undertake a Quick Reaction Engineering development program for the Canadian Armed Services to establish the feasibility of their preliminary design objectives. This company has also undertaken an analytical investigation of the performance of the Canadian air defence system against a postulated jamming threat. The company possesses special skills in the field of electronic warfare and has conducted studies for both Canadian and U.S. military services.

Representative of the military electronic hardware which Canadian General Electric has produced in the period since 1945 are Airborne Fire Control Systems, Search and Height Finding Radars, Communication Systems, ECM and ECCM Equipment, Nuclear Explosion Detection Equipment, Missile Tracking Control Equipment, and considerable sub-contract production associated with various defence systems.





OPTICAL MATCHED FILTER which is used to develop advanced methods of coding radar and sonar signals and thus reach maximum system performance.



## MILLIMETER REFLEX KLYSTRONS

In 1959, Varian Associates of Canada Ltd. initiated the development of a 70 Gc reflex klystron. At that time, the millimeter radio spectrum, 30-300 Gc corresponding to wavelengths of 10-1 millimeters, was practically unexploited for any practical use and few, if any, tubes or hardware were available for experimental work.

The invention of the laser in 1960 and the possibilities which this device suggested at optical frequencies, caused a general slackening of interest at millimeter frequencies. Varian Associates of Canada Ltd., however, pursued the development programme already underway and by 1962, had developed the VA-250 series of reliable and rugged reflex klystrons covering the frequency range 50-80 Gc.

In 1963, it was becoming apparent that the laser was something of a 'will-o-the-wisp' as far as practical usage was concerned, and there gradually occurred a reassessment of the practical value of the millimeter spectrum. In late 1963 and 1964, a dramatic quickening of interest in millimeter hardware took place with a resulting upsurge in demand for Varian of Canada's new klystrons.

Spurred on by this encouragement, Varian of Canada has completed the developed three main series of reflex klystrons covering the millimeter spectrum from 50 Gc to 170 Gc as standard catalogue items. Laboratory prototype tubes have been built as high as 210 Gc, and development is being continued to reach higher frequencies still.

These reflex klystrons have gained wide acceptance throughout the electronic community and are being used on nearly every important research or development project requiring a millimeter frequency klystron in North America. Three series of klystrons are now offered as standard catalogue items, all of which are based on the same basic tube design, but which feature optimized performance of three major parameters; power, tunability and low input.

### HIGH POWER SERIES, 50 - 170 Gc

This series of tubes, each of which mechanically tunes 2 Gc and features guaranteed power outputs unsurpassed by any other reflex klystron, guarantees minimum power of 350 mw at 50 Gc at one end of the series and 75 mw at 170 Gc at the other end.

These tubes find application in microwave spectroscopy, communication transmitters, parametric amplifier pump sources, and maser pumps, where hundreds of milliwatts of power are required and tunability can be sacrificed to obtain more power.

### MEDIUM POWER WIDE TUNING SERIES, 50 - 170 Gc

The tubes in this series are each mechanically tunable over 6 Gc. Tubes above 110 Gc will tune 8 Gc. Featuring somewhat lower guaranteed power, (150 mw at 50 Gc, 50 mw at 170 Gc), these tubes find application where high power is required but tunability cannot be sacrificed.

### LOW POWER SERIES, 50 - 170 Gc

Where the need exists for only a few milliwatts of power, this series can be used with a saving in tube cost and power supply input requirements. These tubes tune 6 Gc, give 10 milliwatts at reduced beam voltage, and find application in radiometers, radar receivers and communication receivers.

The tubes in all series will survive 50 g shock and are rugged enough to be used in airborne and missile applications.

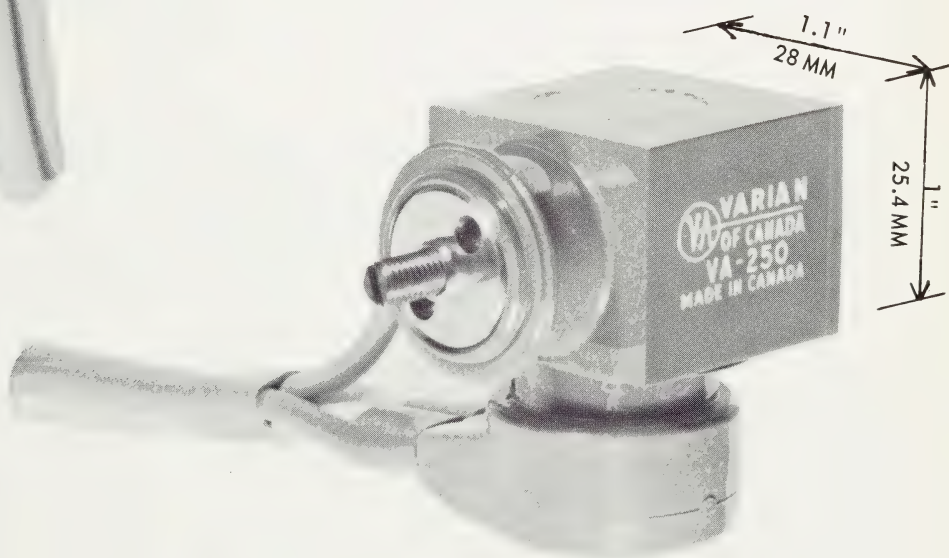
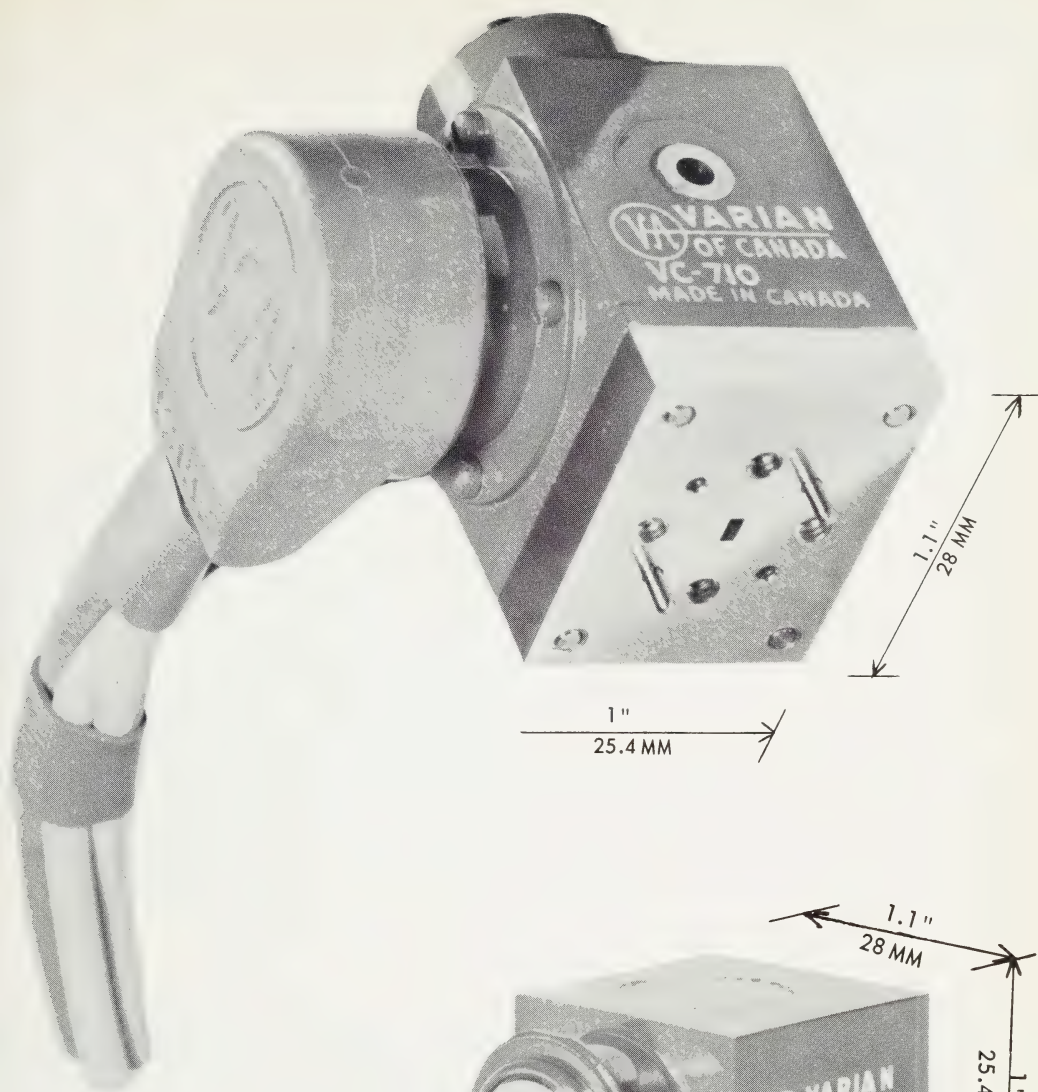
Cooling of these tubes may be accomplished by forced air cooling. This method is quite suitable for a multitude of applications.

Where a high degree of frequency stability is required, the output flange of the tube can easily be replaced by a water cooled heat sink, or alternatively, the tube may be completely immersed in a temperature stabilizing coolant such as FC75 fluorocarbon.

The potential usefulness of millimeter wavelengths is only now becoming apparent.

New techniques needed by our aerospace programmes, by defence and by basic research, ensure that the millimeter spectrum will not be left as a kind of technological vacuum but will, with the advent of practical millimeter klystrons and other components, be much more fully utilized than was thought possible a year or two ago.

Varian Associates of Canada Ltd. has also developed and manufactures a wide range of reflex klystrons at other frequencies — power klystrons, magnetrons, backward wave oscillators and travelling wave tubes.



## PRECISION DEFLECTION YOKES

E.M.I. Cossor is prepared to design and manufacture yokes for any of the following wide range of applications:

- transistor drive
- extra-wide-angle deflection with p.m. correction
- dynamic focusing systems
- compound or dual-deflection systems

Their engineers are often called upon to design and produce deflection yokes to extremely close tolerances.

**YOKE CORES** — All yoke parameters depend strongly on the properties of the core material. Sensitivity and response, in particular, require high permeability and the absence of phenomena causing back magnetomotive forces. Hysteresis causes a memory effect which should be as small as possible for non-repetitive scan applications.

**MUMETAL CORES** — Mumetal cores exhibit the highest sensitivity and the most controllable geometry, resulting in a very precise display, but there is a significant memory and there are slow approach phenomena representable by a back magnetomotive force of 0.4% decaying linearly in 100 microseconds.

**COSCANITE CORES** — Coscanite cores are not as sensitive as mumetal or ferrite, but they have been developed for negligible memory and zero slow approach. The geometrical performance is good and the material is extremely flexible in application.

**FERRITE CORES** — Ferrite cores are nearly as sensitive as mumetal, but their geometry is not quite as good and their memory is of the same order as mumetal.

**NON-MAGNETIC CORES** — Non-magnetic cores are of restricted usefulness, but in some applications such as twin yokes working into the same deflection space, the absence of ferromagnetic materials is desirable.

**ROTARY DEFLECTION YOKES** — Rotary yokes are available with the same inductance values as our standard fixed yokes. Other values will be prepared to suit customers' exact requirements. The yokes are available for single-ended or push-pull drive, and with a single axis or orthogonally axes. Company standardization of housing and yoke outline enable us to offer high-quality prototypes economically. The environmental performance and precise mechanical tolerance of our fixed yokes is duplicated in our rotary yokes. For special applications yokes can be manufactured with reduced overall dimensions without any reduction in the essential performance characteristics.

**STANDARD FOCUS COIL** — The E.M.I. COSSOR standard focus coil is a rugged, efficient, magnetic focusing unit capable of constant operation in the toughest environments. The coil's three main components are a silicon-impregnated winding and the two parts of the case. The winding has attached terminals and may be removed from the case without unsoldering the leads. The case is of machined Swedish iron of a particularly high quality.

**SHORT DEFLECTION YOKES** — There are two situations in which the Standard Yoke will not provide the performances required.

(a) Where the mechanical arrangements on the tube neck, to allow for focus coil location or for other reasons, demand a shorter yoke body.

(b) Where the deflection angle required is greater than 60 degrees ( $\pm 30^\circ$ ).

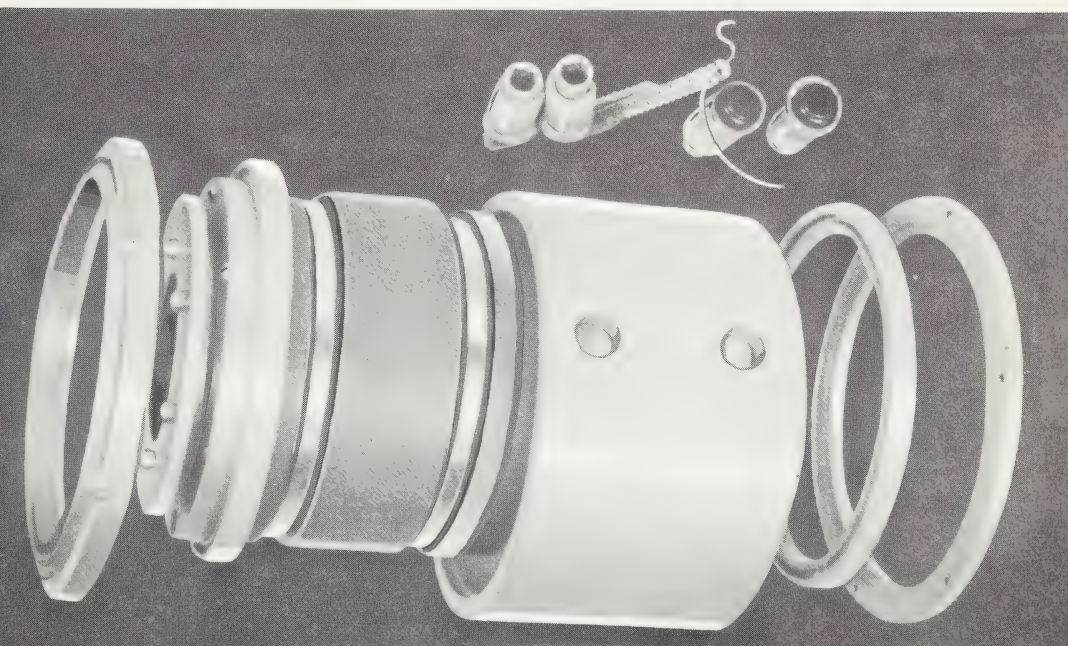
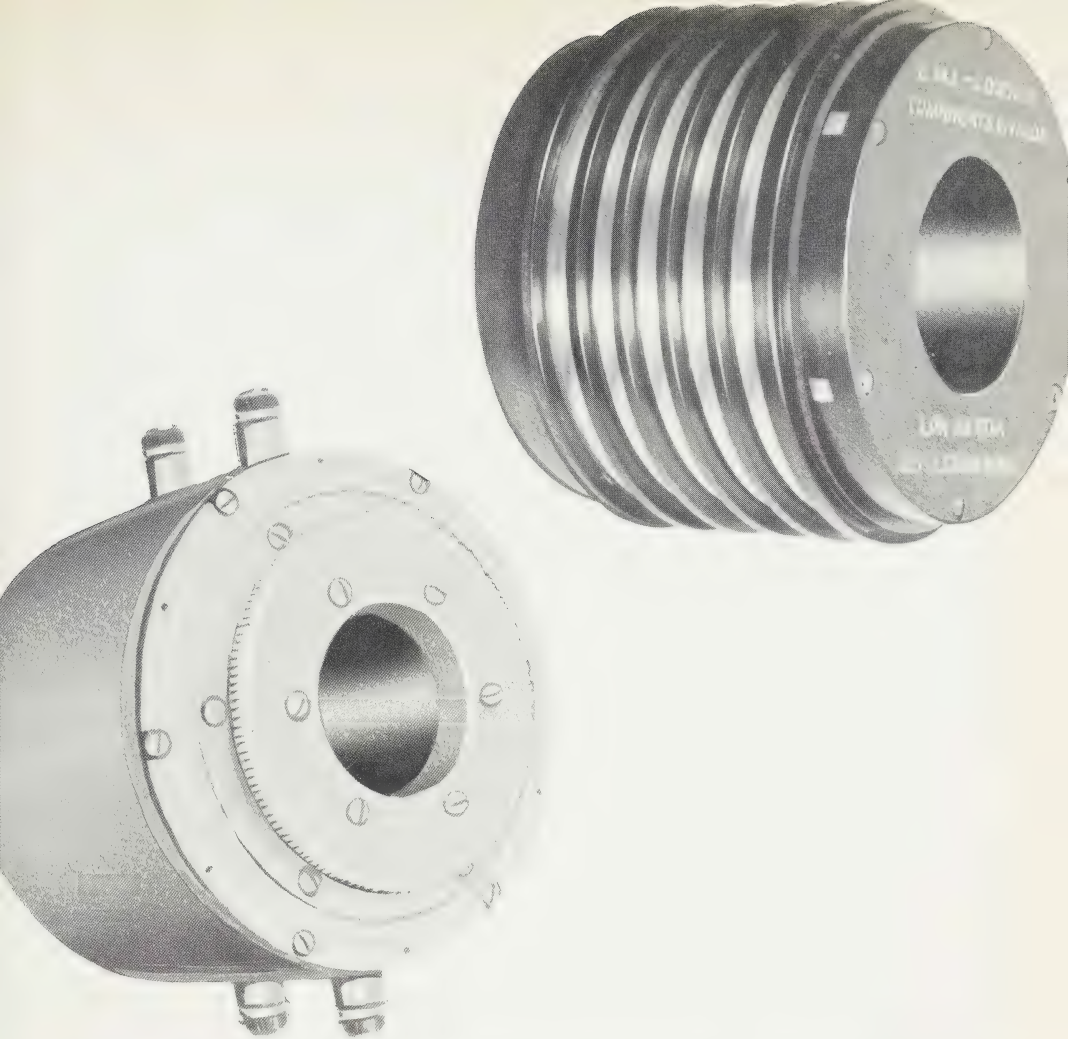
Our new short yoke specifications include:—

Deflection angle — up to  $75^\circ$  (depending on cathode ray tube).

Sensitivity — 15% less than standard yokes for the same value of inductance.

Other properties substantially unaltered.





## SOLID STATE POWER DEVICES

De Havilland Aircraft of Canada Ltd. (SPAR Division) has specialized in the design, development and quality production of advanced military grade solid state power supplies. Electrical ratings range from a few watts to kilowatts of quality regulated output powers and include both static inverters and static frequency changers.

Typical units produced (pictured on the right) are: the 2.0 kw Solid State Power Converter Type SV-34 and the SPS 44 Power Frequency Converter.

The SV-34 is a solid-state, internal fan cooled electrical power converter supplying 3-phase 400 cps sine wave power at levels up to 2.0 kw. The converter is designed for 400 cps equipment calibration and checkout where primary available power is 60 cps. Advantages are a precision output waveform of extreme purity and output frequencies selectable in 1 cps steps between 380 and 420 cps.

This converter is of all-aluminum construction, with a front panel door which swings out to permit easy access to internal circuiting. All circuits are fused and output circuits are metered. The unit weighs 355 pounds (161 kg) and measures 37" x 14" x 30" (92 x 35.6 x 76.2 cm). This can be reduced where requirement of shock to MIL. S.901B may be waived.

Environmental factors are: Shock to MIL S-901B, Vibration MIL. STD. 167. Type 1, Temperature 10°C to 50°C.

Scope of applications include: marine, laboratory, production testing, universities and schools, military and aircraft maintenance depots and level two and three ground support of military electronic systems.

Input power 440 V line-to-line 60 cps. three-wire Voltage variation  $\pm 5\%$  Frequency variation on  $\pm 3\%$  . . . Output power level 2.0 KVA at 0.9 pf lagging. Voltage 115/200 V. 4 wire.

The SPS 44 is a solid state 2.5 KVA Frequency Converter designed to meet the needs for aircraft electrical power conversion. Its primary application is converting frequency-wild primary input power to regulated 400 cps output power. This power converter could typically be used in aircraft power systems where conventional engine driven alternators are directly coupled to the accessory pad, but a medium power source with constant frequency is necessary for frequency sensitive electrical equipment.

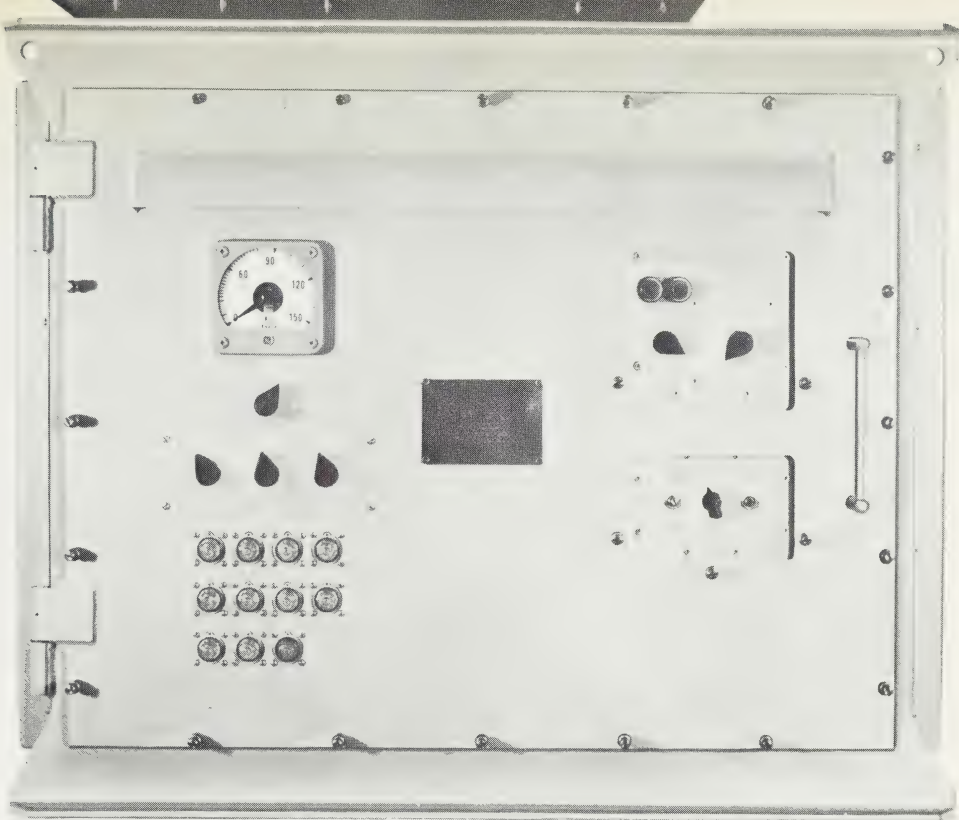
This unit weighs 33 pounds (15 kg) and measures 19.5" x 7.5" x 7.5" (49.5 x 19.1 x 19.1 cm) and is forced-air cooled by an internal fan. Input power 100-120 Volt runs line-to-neutral, 300-550 cps, 3 phase, 4 wire. Output: 112.5-118 volts rms line-to-neutral, 400 cps  $\pm 2\%$ , 3 phase, 4 wire.

Environmental factors are: Shock; para 3.2.21.6 of MIL-E-5272 procedure 11 EM1; MIL 1-6181 Vibration curve 1 of MIL-E-5400. Temperature: — 54°C to 71°C, 85°C for 5 minutes. Altitude 36,000 feet (1098 m): Salt spray MIL-E-5272 procedure 1, Sand & dust MIL-E-5272 procedure 1.

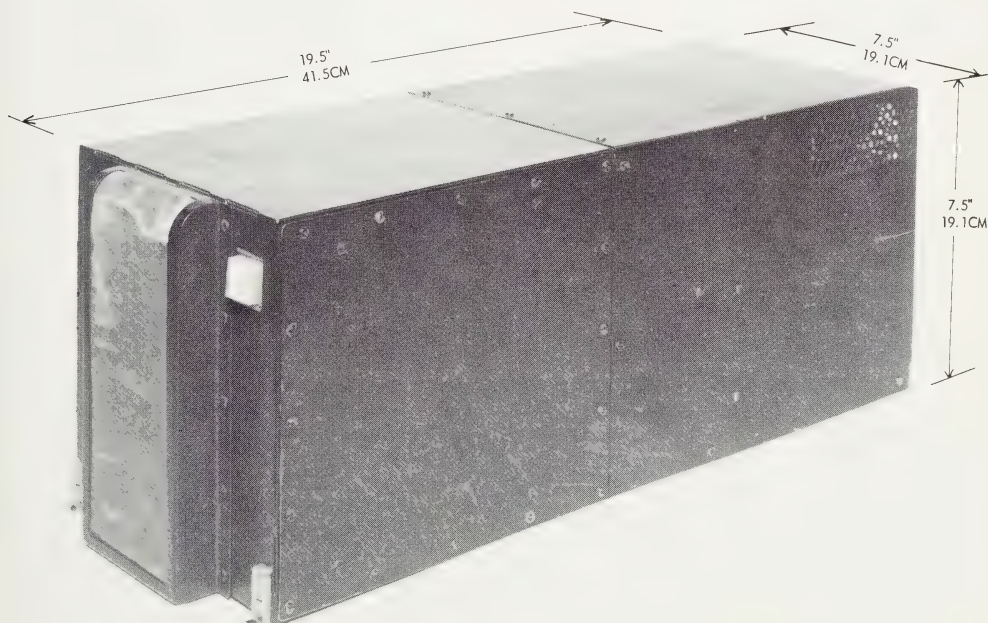
The SPS 44 is designed for aircraft, vehicular and marine applications.

These products represent some of the creative outgrowths of the SPAR Power Conversion Group. Current development and production in static inverters and frequency changers include new designs and modular concepts for the military aerospace industry.





The SV-34 is a Solid State, Internal Fan-Cooled Electrical Power Converter Supplying 3-Phase 400 CPS.



The SPS 44 is a Solid State 2.5 KVA Frequency Converter.



## POWER SUPPLY PP-5143/PRC

The Power Supply PP-5143/PRC is a voltage regulated solid state power supply designed as a power source in lieu of batteries for bench testing man carried portable military communications transceivers such as the PRC-8, PRC-9, PRC-10, PRC-509, PRC-510, CPRC-26 and the new PRC-25 equipments. In addition it will serve as a very useful general laboratory or workshop power source.

The unit consists of four independent adjustable regulated supplies capable of the following outputs:

- No. 1 — Adjustable from .95v to 3.0v at 1.0 amp maximum
- No. 2 — Adjustable from 3.0v to 15.0v at 2.0 amp maximum
- No. 3 — Adjustable from 32.0v to 70.0v at 30 ma maximum
- No. 4 — Adjustable from 65.0v to 150v at 60 ma maximum

A meter selector switch connects the front panel meter to monitor the output of each supply. Each supply has mounted on the front panel an individual ON/OFF switch, a voltage adjust control and a pair of output terminals. Each supply output is available at a barrier terminal strip located at the rear of the instrument. In addition output cables can be supplied terminated in the appropriate connectors for direct connection with the above-mentioned communications equipment.

Each of the four supplies is protected from overload by an automatic electronic cut-out designed to trigger at about 150% of rated output current.

The unit is powered by either 115 volt or 230 volt 50 to 60 cps single phase line source and is designed for mounting into a standard 19 inch equipment rack.

This equipment has been produced by Canadian Admiral Corporation Limited for the Canadian Armed Forces to the requirements of Canadian Specifications CA-P-204.



# SOLID STATE DIGITAL TO VIDEO CONVERTER DISPLAY SYSTEMS

RCA Victor Company, Ltd. of Montreal has developed a digital to video converter system under the trade mark DIVCON which is receiving considerable acceptance in the defence, space and commercial markets of Canada, United States, Great Britain and other countries. The most dramatic application of this system has been on TV broadcast of the Canadian, U.S. and U.K. elections, where the returns were posted directly to TV displays to give various standings.

In addition to TV networks, the DIVCON system has also been accepted by stock exchanges, airlines, and defence space agencies for various applications of data display and information retrieval. Air Canada and British European Airways have adopted the DIVCON display system and for stock exchange applications, the DIVCON system has been adopted by the Canadian and Chicago exchanges.

The DIVCON system converts information in the form of digital coding to equivalent 525 or 625 line video signals for display on standard TV monitors and receivers. The information appears with excellent clarity in the form of printed messages.

Principal features of the DIVCON system are:

- Large, medium and small size characters.
- Selective erase, X-Y addressing, roll-up, roll-down, transmit, print-out, and light probe select options.
- Input line adapters for teletype, data-phone and computer parallel interface.
- Multiplexing capability for 150 display pictures and one video channel utilizing local refresh memories.
- Converters available with up to 16 video output channels.
- Eight color capability.

Following are typical specifications for the DIVCON display system:

<i>Number of Channels:</i>	Two channels each with composite and non-composite outputs.
<i>Number of Characters:</i>	Channel 1: 15 lines of 32 medium characters per line. Channel 2: 10 lines of 16 large size characters per line.
<i>Display Storage Capacity:</i>	One frame of Channel 1 and two frames of Channel 2 information. (One Channel 2 frame can be displayed while other frame is being loaded).
<i>Keyboard:</i>	Custom built with 53 characters and symbols comparable to those found on standard typewriter keyboard.
<i>Input Code:</i>	Baudot input code enables acceptance of parallel signals from standard teletype equipment.
<i>Input levels:</i>	Ground for Bit 1, + 6 volts or open for Bit 0.
<i>Circuitry:</i>	Integrated circuits throughout.
<i>Power requirements:</i>	Approximately 1500 VA at 115 V 60 cycles single phase.
<i>Sync source:</i>	EIA sync generator (optional).

## MECHANICAL:

Height 78" (180 cm) — Width 28" (70 cm) — Depth 24" (61 cm)

Weight 950 lbs (431 kg)

## ENVIRONMENTAL:

Ambient temperature 50F to 100 F. (10 C to 37.7 C)



COO AND MATCHING FOR VARIOUS  
ADJACENT ELEMENTS IN DIGITAL  
DISPLAY SYSTEM

POTENTIAL APPLICATIONS ARE  
AIRLINE OPERATIONS  
AIR TRAFFIC CONTROL  
WEATHER OFFICES  
STOCK EXCHANGES  
BRANKING MACHINES  
TV NEWS BROADCASTING  
TRANSPORT DISPATCHING  
WAREHOUSE CONTROL  
COMBAT OPERATIONS CENTERS  
DATA LOGGING

## LINATROL TRACING SYSTEM

A Canadian product which has achieved overseas distribution has afforded the small metal-working shop the same automation features as its bigger competitors.

An electronic line tracing attachment for small flame-cutting machines, the device has various names depending on where it is sold. In Europe and the United Kingdom, distributed by Messer Griesheim, Frankfurt, Germany and London, England, the unit is called Photoskop. The Air Reduction Company in the United States sells it as the Aircotron. Canadian Westinghouse, designer and manufacturer of the equipment, markets it in Canada under the name Linatrol Type HL6.

Whatever the name, the device is being well received wherever it is displayed. It can be fitted to a small flame-cutting machine in a matter of minutes — operates by following a simple line drawing — and produces the finished part automatically.

Designed for trouble-free operation Linatrol HL6 was rigorously tested under working shop conditions before being offered to the market. In the event repairs become necessary they can be carried out in the field through a system of modular replacement parts.

Linatrol HL6 is the latest in a line of electronic tracers produced by Canadian Westinghouse for the control of flame-cutting machines. Other types of Linatrol available are the Type HL2 and HL41.

The Type HL2 Linatrol was originally developed to fill an urgent need for a practical device to provide fully automated precision control and guidance for gas-cutting machines and to replace manual or semi-mechanical methods such as template tracing.

The Type HL2 consists of a Sensing Head and a Control Cabinet. The Sensing Head is normally combined with a friction drive mechanism by the user, to form a Tracing Unit which is propelled over the drawing. The Control Cabinet contains the servo electronics and controls for the Tracing Unit.

Type HL2 is ideal for use in tracing operations where low thrusts and low speeds are involved. It will trace with a high degree of accuracy — within  $\pm 0.010$  inch of the centre of the pattern line.

The co-ordinate drive system developed by Canadian Westinghouse is completely transistorized and employs plug-in printed circuit cards to reduce maintenance problems and to lower maintenance costs. The use of plug-in circuits permits the rapid isolation of a possible fault, and simplifies trouble-shooting techniques.

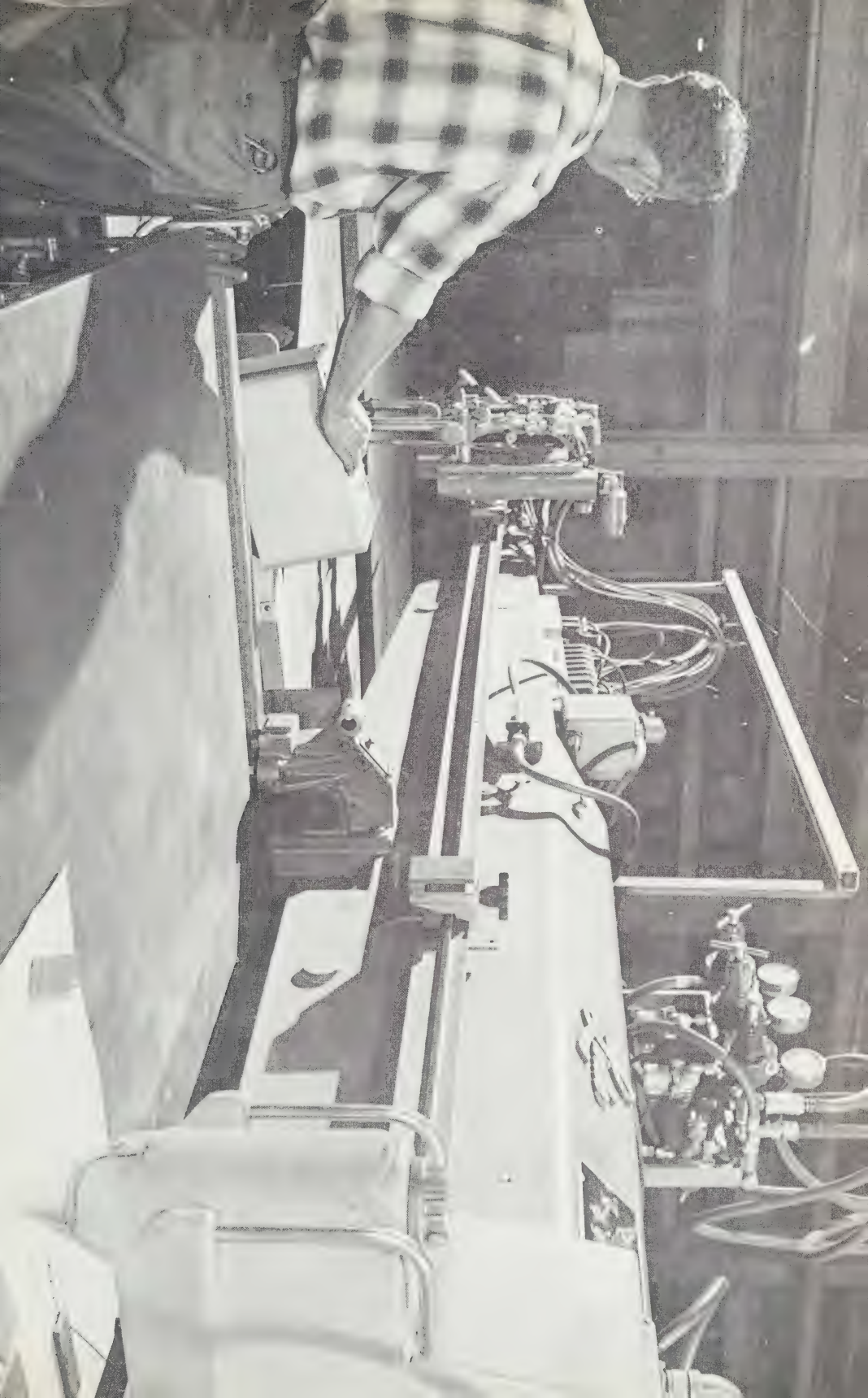
Linatrol co-ordinate drive Type HL41 comprises five basic units; namely, tracing unit, control unit, amplifier unit, X drive unit, and Y drive unit. These units are fitted, for example, to a router to form a single integrated machine. All machine motion controls are housed in the control unit which can be located in the most advantageous operating position. Controls are individually lighted and have been engineered with a view to minimizing human error. The tracing unit is only 8-1/4" (21 cm) wide, permitting maximum working width of the drawing table.

The drives of the normal production model produced by Canadian Westinghouse terminate at the shafts of drive motors in the X and Y drive units. Generally, the 'machine manufacturer' prefers to provide the drive mechanism (consisting of a speed reduction unit, clutches, etc.) required to couple the X and Y drive units to the X and Y carriages of his machine. If deemed necessary, however, Canadian Westinghouse can also supply the drive mechanism.

The positive non-friction co-ordinate drive motors provide great thrust in both axes (over 300 pounds (136 Kg) continuous when geared for a speed of 50 i.p.m.) (127 cm pm), coupled with high machine driving speeds. This available thrust permits the control of machines having high tool pressures or possessing large moving members, such as flame-cutting machines. Fast line tracing speeds are possible, depending upon the speed reduction of the drive motors and the type of machine — from 0 to 250 i.p.m. (635 cm pm) or greater.

To achieve optimum performance of a machine utilizing Canadian Westinghouse control equipment, the company has designed, as a part of the control system, an electric "frequency compensation" circuit to minimize the effect of machine resonance. Final adjustment of this circuit is made after a 'resonance search' of the complete system.

Many hundreds of Linatrol units are in the use throughout the world and the Company's engineers are currently developing the Linatrol System for such applications as wood and metal routing and nibbling machines.





## **TELEPATH COMMUNICATIONS & DATA CONTROL EQUIPMENT**

TELEPATH is the trade name for a line of Solid State communications and Data Handling equipment designed and produced by CAE Industries Ltd. for the Telegraph and Digital Communications industry.

The product line covers the range of Selectors, for controlling terminal on-line equipment such as Teleprinters, Card Punches, Tape Readers, etc. In addition, a line of code translation equipment is available, enabling any of the common communication and data codes to be translated to common telegraph language forms.

TELEPATH Selector units provide facilities for the control and coupling of Teleprinter equipment to Tape, Card-Punch, and "On-Line" Computer processing systems. Selectors are also used as part of Message Switching Networks to supply station control and supervision from a central processor.

All equipment is designed to provide an Operating Time Between Failure of better than two years.

Security and Parity checking facilities are available if required.

The TELEPATH line of products has been sold for application in military and commercial flight control, and reservations systems using computer processing equipment with units in service throughout the world by a number of major airlines and other common carriers.



REQUEST



ALARM



POWER ON



.50 AMP  
115 VAC



ON

OFF

## NUMERICAL CONTROL—MACHINE TOOLS

The automation of standard machine tools for short run production has reached new peaks of practicality and economy with the development of the UMAC 5 numerical control system by Sperry Gyroscope Company of Canada, Ltd.

This modern solid state control embodies extremely advanced design and construction techniques to provide the machine tool builder and end user with outstanding technical and operational features.

In addition to the high performance servo components required in a modern control, UMAC 5 incorporates a unique digital computer. This computer is used to perform a large variety of functions, such as automatic tool off-setting, zero shifting, position determination, post processing—and it performs them all at a reasonable cost.

The numerical control system was conceived and is built on a building block basis, and may be purchased in this manner also. This means that from a relatively simple application at the start, additional degrees of automation may be added at will.

UMAC 5 adapts to any machine tool and machine tool requirement. The character of the machine tool and its application requirements are translated into a computer program and then fed into the system's computer which sets up the control for that particular machine tool application.

If any changes are required at a later date, or if the system has to be expanded to take care of extra machine components such as a rotary axis or the addition of a tool changer, the computer is simply reprogrammed and additional boards containing the necessary hardware are plugged into pre-wired panels.

The machine tool builder uses this feature to adapt the numerical control to any machine, but it is also most important to the end user, for it means that he can retroactively expand his machine to meet changing requirements as they arise.

This system meets the requirements of published North American Machine Tool tape format standards. The digital computer also makes it possible as an option, to allow the control to read and interpret non-standard formats.

Other features of this system are: storage of complete sequences of machining operations that may be repetitive; position measurement and in process inspection; the selection of up to 99 tools with individual Z-axis zero offsets stored in the memory for each tool; tape search cycle; control panel for manual operation; optional metric programming.

The absolute electrical accuracy of UMAC 5 is  $\pm 60$  millionths to  $\pm 150$  millionths of an inch depending on choice of feedback device.





## “AQUA-JET”

The Tamco Hydro jet propulsion system — “Aqua-Jet” was produced with the aid of the Department of Defence Production and the U.S. Army and has been successfully tested by the U.S. Army with a report noted in the December 1966 issue of the U.S. Army Research and Development Newsmagazine.

The equipment tested by the U.S. Army was propelled by two jets powered by twin Chevy II 110-horsepower gasoline engines, has a fiberglass hull 25 feet 6 inches long with a beam 7 feet 10 inches (7.7 x 2.4 m). It has a 25-knot capability empty, a maximum speed of 15 knots with a 2,000-pound load (907 kg), can be rotated 360 degrees for steering maneuverability and can be used in 13 inches of water (33 cm). It should be noted that each jet intake on this boat was equipped with a weed cutter which ensured constant power and propulsion through weed infested water.

Other versions of the boat are 16-foot (4.9 m) models of the Hunt design fiberglass hull equipped with twin jets and powered by 85 h.p. Perkins Diesel engines with hydraulic steering, a Tamco development which is a new innovation solving many of the existing problems associated with water jet propulsion systems. Here the total weight of the fully equipped boat is 2,200 lbs (1 metric ton) and attains a maximum speed of 30 m.p.h. (48 k). Still other models are 18-foot (5.5 m) which presently are being employed as utility life boats, approved by Canadian Steamship inspection, again equipped with Aqua-Jets and hydraulic steering but powered by 160 h.p. Perkins Diesels where the total weight is approximately 3,200 lbs (1451 kg) and again the speed is 30 m.p.h. (48 k).

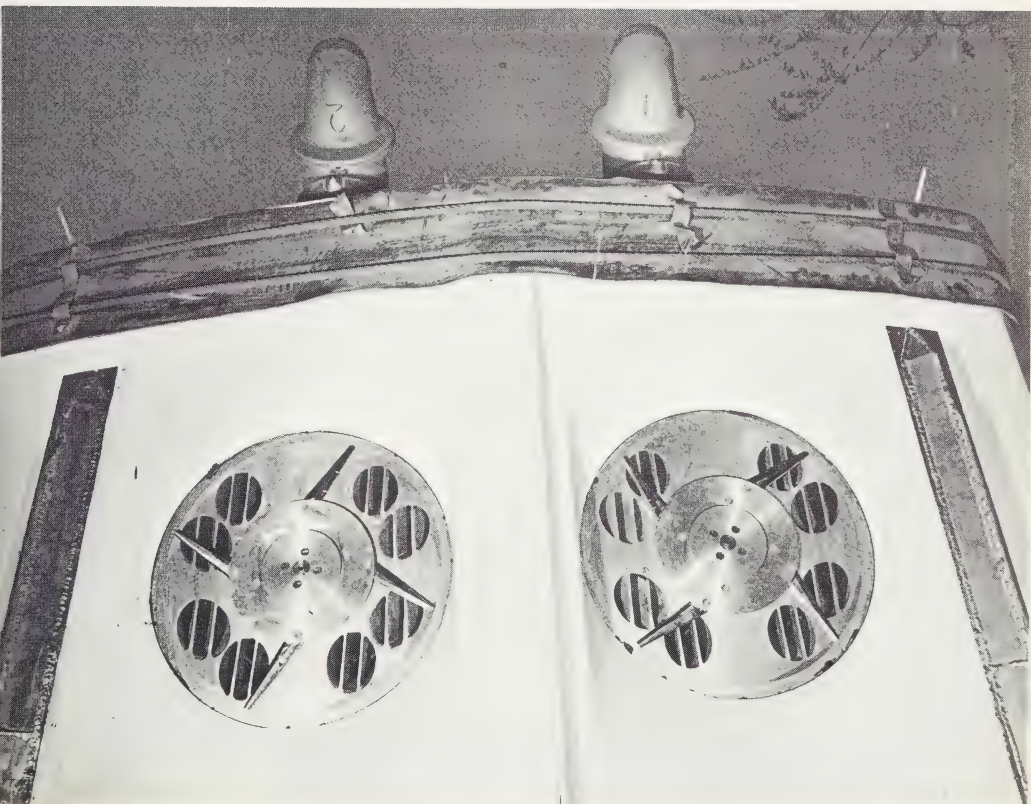
While water jet propulsion systems are not new, the advances made by such companies as Tamco over the last few years have served to ensure that the equipment has become a reliable fact as opposed to a questionable “gimmick”. It is because of these proven advances that both builders and naval architects, who are basically conservative, are now consistently employing to advantage jet propulsion systems. The area where Hydro jet propulsion is forging ahead appears mainly in the field that requires a rugged drive with maximum thrust to overcome the many obstacles which are present in other types of drives resulting in damages to the propeller and the boat itself — due to the draught required of conventional craft.

The Tamco “Aqua-Jet” is a Canadian designed propulsion system which has many varied and progressive features consisting in the main of an axial flow pump which, as such, requires no detailed description but what sets it apart is the intake and weed cutting arrangements whose design is based on years of experimental work whose final success was ensured by field trials.

The object of breaking up the intake into eight sections is to avoid the formation of one excessive suction point and, as the total suction force is thus divided by eight, its pickup power is correspondingly reduced. The eight intake ports are so laid out that the shearing action of the rotating blades serves as an effective weedcutter. Weeds entering the intake ports are either cut into short lengths which are inducted into the system, or deflected by the rotating blades. Provision is made to disengage the weedcutter when not in use. All of our trials have shown that the weeds cannot clog the ports. The design and construction of the multi stage pump is such that it effectively further reduces the ingested material, permitting free passage through the unit.

The Tamco Aqua-Jet has found that its basic uses to date are in the following fields.

- Coast Guard employment for speed and maneuverability in close in coastal waters, a continuing problem particularly where tidal features are concerned.
- Fisheries operations or patrol where net protection afforded through shallow draught and maximum maneuverability are requisites.
- Forestry and logging where durability and rough going due to submerged obstacles make conventional craft employment impossible or costly.
- Fire protection service in shallow draught areas.
- Mining, Technical or Topographical service in shallow or weeded water areas.
- Military applications into shallow draught areas where normally troops would be ford or wade with a resultant discomforture and loss of time as well as load carrying capability.





## HYDRAULIC BOAT CONTROLS

This system affords fingertip control and sensitivity. In essence, it is a motor mounted pump that generates line pressure which is valve controlled in activating the cylinders for to and fro steering and reversing motion.

The pump, mounted at the front of the engine, is driven by a V belt from a crankshaft pulley. The circulating circuit which is normally open so that the pump, while circulating oil, is not generating over pressures so that the valve remains in a centre position thus leaving a through passage for the circulating oil. This circulating oil issuing from the pressure outlet of the pump flows through the reversing valve and is directed to the steering valve and then to the return line back to the pump tank.

### REVERSE THRUST

Reverse thrust is employed by reversing the nozzle through directing the oil flow into the blind end of the reversing cylinder. The pressures generated on the cylinder rod and the rack rod swing the nozzle into reverse. With the reversing procedure in effect and the controls neutralized the reversing valve allows free circulation again with the nozzle held in reverse by the oil locked in the reversing cylinder. The reversing cylinder being part of the steering arm ensures that the nozzle is held in the reverse position while the steering arm responding to the wheel can now swing the nozzle to any desired position thus giving reverse steering.

### FORWARD THRUST

In forward thrust the reversing lever is moved forward so that the reversing cylinder will allow the nozzle to swing from reverse to forward once the circuit has been again opened for free circulation of oil; again the oil will be trapped in the cylinder and lock the nozzle in forward drive.

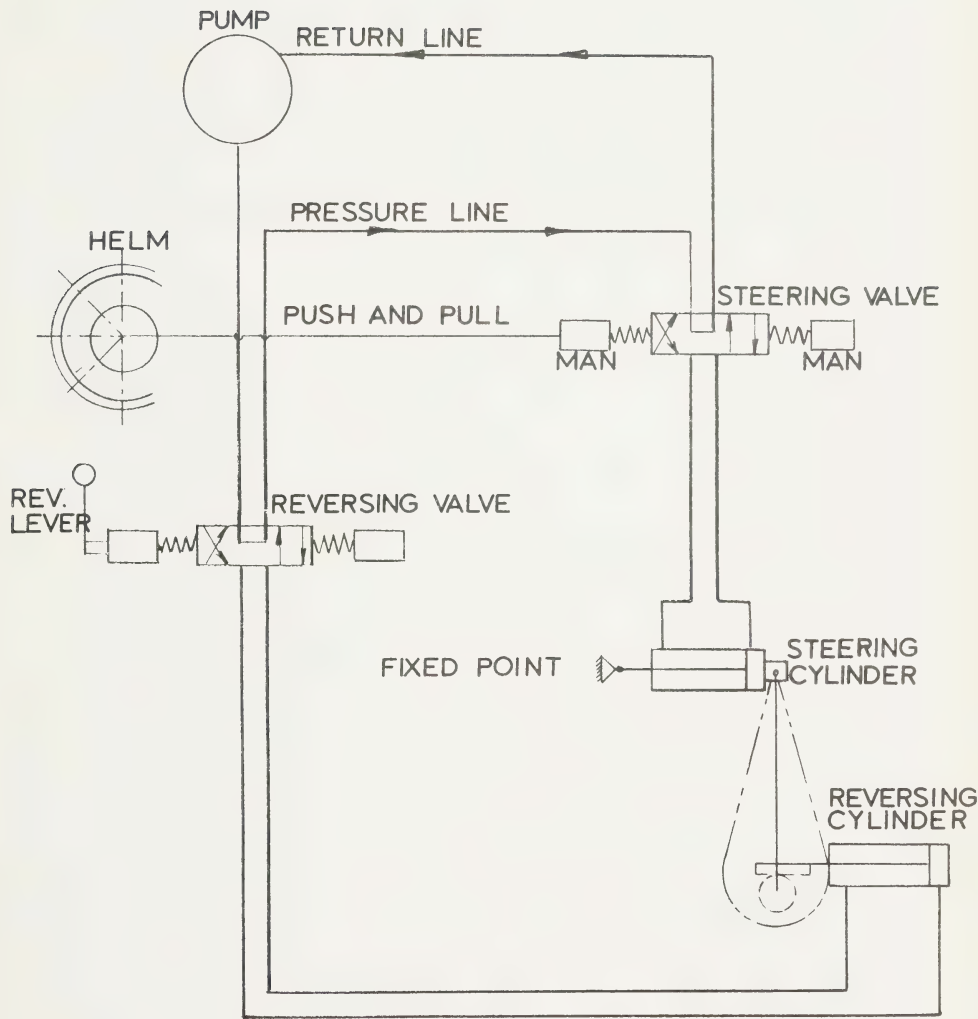
### STEERING

The valve that controls the steering is mounted "piggy-back" on the steering cylinder. This valve is normally open as part of the open circuit and allows the oil to flow through freely. Wheel motion instantly changes this open circuit condition as it shuts off the open circuit to divert the flow of oil to the steering cylinder. The instant that the steering wheel motion is stopped, the oil is locked in at both ends of the cylinder, holding the nozzle rigidly in the position it is at that instant. The flow-through parts of the valve open at the same time allowing the oil free passage through the return line to the pump tank.

This equipment is very often used in conjunction with Tamco Aqua-Jet boats or it may be employed as a separate feature.

*(See page I-150 for the Aqua-Jet.)*

GRAPHICAL DIAGRAM  
OF HYDRAULIC STEERING  
AND REVERSING CIRCUIT



## HELICOPTER HAUL DOWN SYSTEM

The Helicopter Haul Down System was designed to enable helicopters to operate at sea from small flight decks in rough weather conditions. The Rapid Securing Device, Reaving System and Control Console were designed and manufactured by Fairey Canada Ltd., Dartmouth, Nova Scotia. The Winch Unit, Power Pack, Rope Accumulator and Control System were designed and manufactured for Fairey by Dowty Equipment of Canada Ltd.

The illustration on the opposite page shows the various components used to land, secure and manoeuvre a helicopter onboard ship. The equipment is designed to handle a helicopter of 20,000 pounds (9072 kg.) gross weight in sea states causing roll of  $31^\circ$ , pitch  $8^\circ$ , and heave up to 20 feet (6 m.) per second. The system operation may be considered in three phases: (1) Landing on the flight deck; (2) Securing as soon as possible after landing, and (3) Manoeuvring into the hangar. One man stationed at a remote control console can control this sequence of events from the ship.

A landing operation is carried out as follows:

A line is lowered from the hovering helicopter and connected to the haul down cable end fitting, which is subsequently winched up and locked in a housing in the helicopter bottom fuselage. The haul down cable is reeved around a drum in the winch compartment of the ship and this drum, powered by a hydrostatic transmission, is operated to winch the helicopter under a selected and controlled tension, to the flight deck. Tension selected at the control console will remain approximately constant regardless of ship motion, so that the helicopter will be drawn slowly and smoothly down to the flight deck. This constant tension feature is achieved through the use of a servo system which compares cable tension, measured by a load cell, with a command signal or tension selection at the console. The resultant error signal is used to control the output of a variable displacement pump, causing the haul down cable to be reeled in or out and to maintain the required cable tension. Rate of descent can be controlled by increasing or decreasing the tension selected.

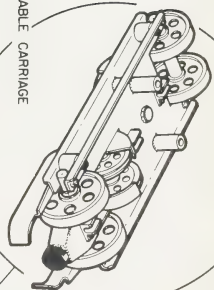
As soon as the helicopter has landed, the Rapid Securing Device, known colloquially as the "Beartrap", is actuated. The Securing Device is a steel structure about 6 feet (1.82 m.) square and 8 inches (20.3 cm.) high, and contains two mutually opposed parallel Arresting Beams. These beams are remotely closed and opened from the control console by the securing device electro-pneumatic system, using two 3,000 psi (1360.8 kg/645 mm<sup>2</sup>) air bottles within the securing device as a source of power. In the closed position, both beams lock together and secure the helicopter probe protruding from the bottom fuselage. When the beams have closed and locked together on the probe and the helicopter tail probe is lowered, the helicopter is restrained on deck against motion in all directions.

The operation is completed by straightening the helicopter on the flight deck by traversing the securing device aft, with the helicopter attached, and then forward along the centerline of the deck into the hangar. A separate winch drum and cable system is provided for traversing the securing device on the flight deck. Forward and aft buffers are used to cushion the securing device at the ends of its travel. The Cable Carriage transports the electrical cable supplying electrical services to the securing device.

With modifications to Securing Device and Winch Control System, this equipment can be used to operate most types of helicopters.



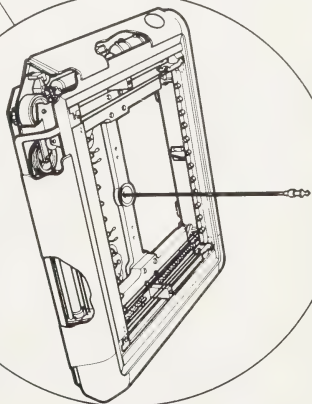
CABLE CARRIAGE



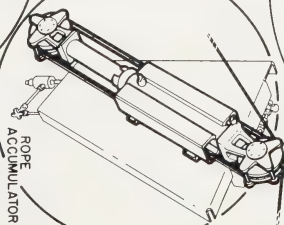
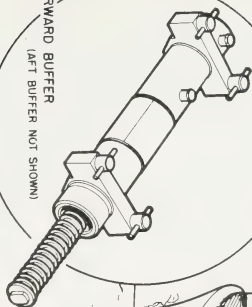
HAUL DOWN CABLE  
END FITTING



RAPID SECURING DEVICE  
(COCKED POSITION)

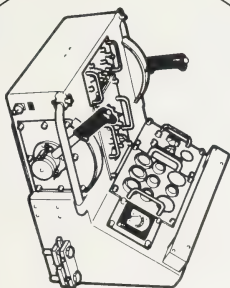


FORWARD BUFFER  
(AFT BUFFER NOT SHOWN)

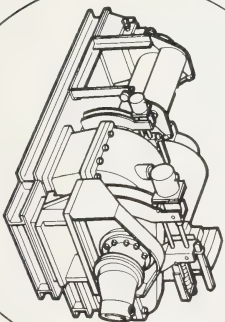


ROPE  
ACCUMULATOR

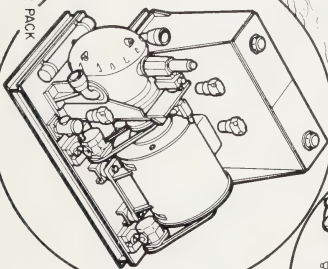
CONTROL CONSOLE



DUAL WINCH DRUM UNIT



POWER PACK



## RETRACTABLE REPLENISHMENT POST

As rapid high-line transfer at sea of solid stores, ammunition, etc., has become a major factor in present day naval operations, it is becoming increasingly necessary to equip all fighting ships with high-line attachment points which will enable them to carry out transfer operations smoothly and efficiently—under all weather conditions, day or night, while maintaining speeds up to 20 knots or better.

After extensive investigation into the problems associated with such operations, Peacock Brothers Limited has developed a retractable replenishment post to meet this need, and the company is now under contract to supply a number of these units for installation in ASW ships of the Royal Canadian Navy. The post is designed to operate in conjunction with supply vessels equipped with constant tension high-line gear and ensures the precise landing of transferred stores within a very small receiving area, even under extreme conditions of heeling and pitching.

As a permanently rigged post, on some types of ship, could impede helicopter operations and interfere with other deck activities, the Peacock replenishment post provides the advantage of being retractable and self-stowing below decks when not in use. It can be erected from stowed to operational position within three minutes.

This replenishment post has been designed primarily to suit transfer operations involving side-to-side clearances between the receiving ship and the supply vessel ranging from a minimum of 100 feet (30.48 metres) to a maximum of 200 feet, (60.96 metres), although, with modification, other distance could be accommodated. It will adjust automatically to variations in station-keeping up to thirty degrees ahead or astern.

The post itself is of box section, fabricated of high tensile structural steel, and of sufficient height to enable the high-line to carry the stores well above the water at mid-travel and also clear of the deck edge at maximum angle of heel.

Arranged to fit around the box section of the post, and provided with rollers on which it can be moved up and down, is a fabricated pad-eye assembly. It is to this travelling pad-eye that the high-line is attached.

To install the Peacock replenishment post, it is only necessary to provide a vertical trunk, 18 inches (45.72 cm) square inside dimension, of sufficient depth below the operating deck to accommodate the length of the post when stowed, and over the open top of which the mounting base of the unit is bolted. The inside surfaces of this trunk must be smooth and unobstructed, i.e., no rivet heads, stiffeners or other projections.

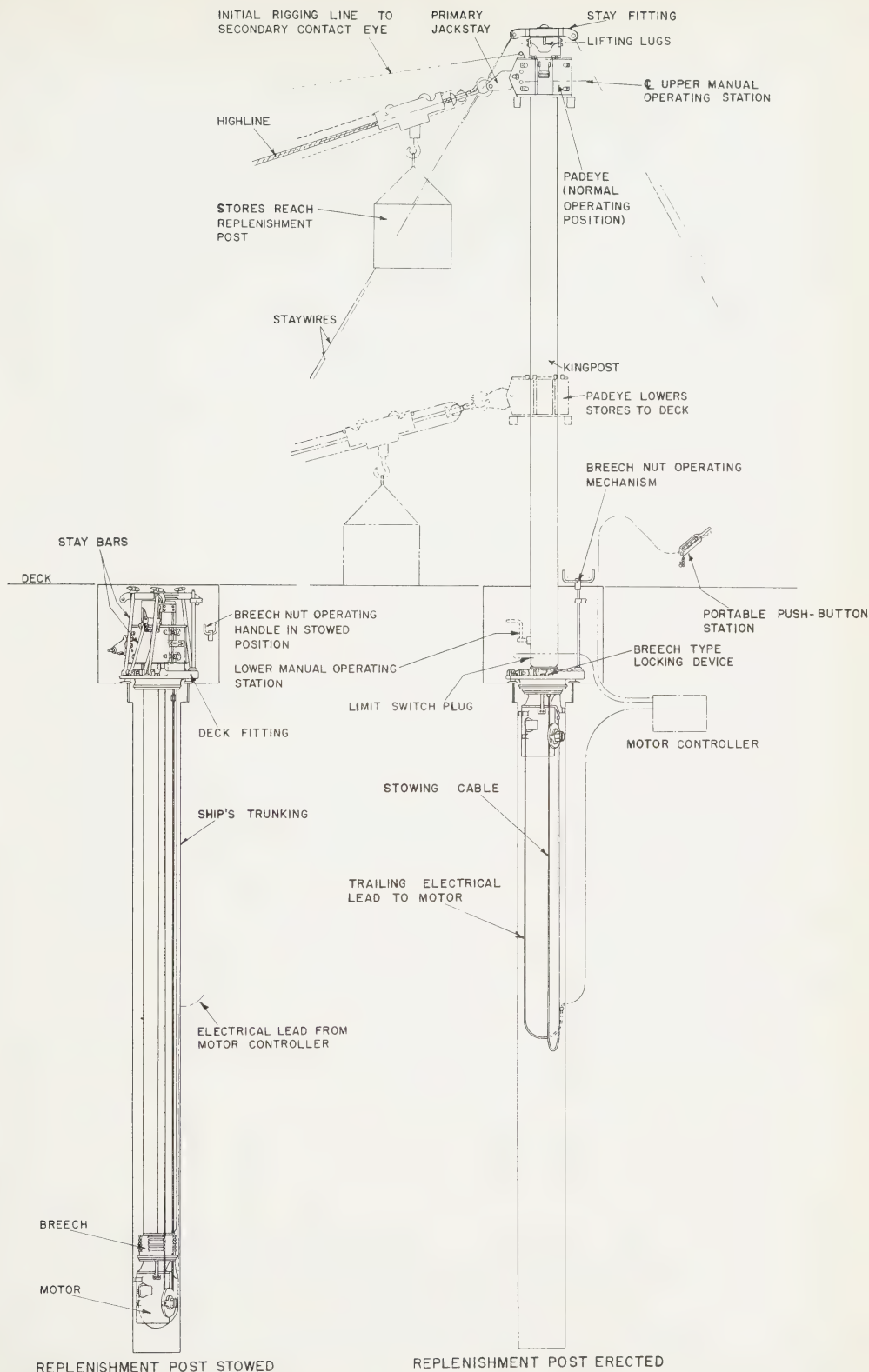
The trunk terminates at the top in a watertight hatch with inside dimensions of 4 feet by 3 feet, by 3 feet high, ( $1.21 \times .91 \times .91$  metres). This hatch can be situated above the deck surface in the conventional manner or be recessed so that the cover is flush, leaving the deck completely unobstructed when the replenishment post is in its stowed position.

The driving mechanism, which is operated by an electric motor, is housed within the box section of the post and is used for the dual purposes of erecting and retracting the post and of raising and lowering the travelling pad-eye. Provision has also been included for manual operation, in the event of electrical failure.

All movements of the post and pad-eye are controlled from a push-button station which is held in the operator's hand and provided with a long flexible lead.

When erected to its operating position, the post is held in a special deck fitting within the hatch by a breech type locking device and is supported at the top by pre-stressed stay wires. Both top and bottom of the post are fitted with self-aligning bearings, so that no restraint is imposed upon deflection induced by the high-line tension.

Several designs of differing capacity are available.





## PRECISION DEPTH SOUNDER

The Model 9040 Depth Sounder is a modern echo sounding equipment designed and built to meet the exacting requirements of a broad Military and Civilian market. These requirements include — high accuracy, linear recording, ease of operation, portability, solid state construction and moderate price.

This Depth Sounder is based upon a number of basic functional modular elements which utilize state-of-the-art techniques and components developed in the Sonar field in particular and the Electronics field in general. The Depth Sounder consists of two (2) units. A single cast aluminum case  $19'' \times 14'' \times 11\frac{1}{2}''$  (48.3 cm  $\times$  35.5 cm  $\times$  29.2 cm) contains the transmitter, the receiver, the linear depth recorder and all operator controls. The weight of this unit is 50 pounds (22.7 kg). The transducer, which functions alternately as projector and hydrophone, is contained in a separate housing and is interconnected with the electronics unit by a single cable. The transducer normally furnished is the Model 9042 Depth Sounder Transducer. This is a high efficiency, low Qm unit which is 10 inches in diameter and 8 inches high (25.4 cm  $\times$  20.3 cm) and weighs 12 pounds (5.5 kg). The conical lobe suppressed beam is 20 degrees at  $-3$  db. Other transducers, more or less sophisticated, are available; the choice being determined by the intended use and operating frequency of the Depth Sounder.

The accuracy of the depth recorder is set by a crystal controlled reference oscillator. The standard reference crystal frequency is based upon an assumed sound velocity of 4,920 ft./second (1499.5 m/sec). A range of plug-in crystal standards is available. The accuracy of the depth recorder is unaffected by wide change in power supply voltage (and frequency).

The Depth Recorder has been designed for bulkhead mounting. It may be operated in a horizontal position (without securing the unit to a deck or horizontal platform).

### DESCRIPTIVE DATA:

<i>Power Consumption:</i>	150 watts (24 VDC, 115 V, 60 cps, as required)
<i>Sounding Frequency:</i>	24 kHz
<i>Range Scales:</i>	0 — 720 feet (0 — 219.5 m) in nine ranges 0 — 720 fathoms (0 — 1316. 7 m) in nine ranges
<i>Pulse Length:</i>	1 to 40 ms (depending on scale)
<i>Pulse Repetition Rate:</i>	736 to 31 per minute (depending on scale)
<i>Recording Paper Speeds:</i>	0.1, 0.5, 1.5, 3 and 6'' per minute 2.54, 12.70, 38.10, 76.2 and 152.4 mm per minute

### SPECIAL FEATURES:

1. Draft adjustment
2. Marker facility
3. White line effect
4. Manual over-ride for 1 ms pulse on any range
5. Time-varied-gain receiver characteristic.

This equipment, designed and produced by Edo (Canada) Ltd., should be considered along with the Remote Depth Indicator on Page I-160.

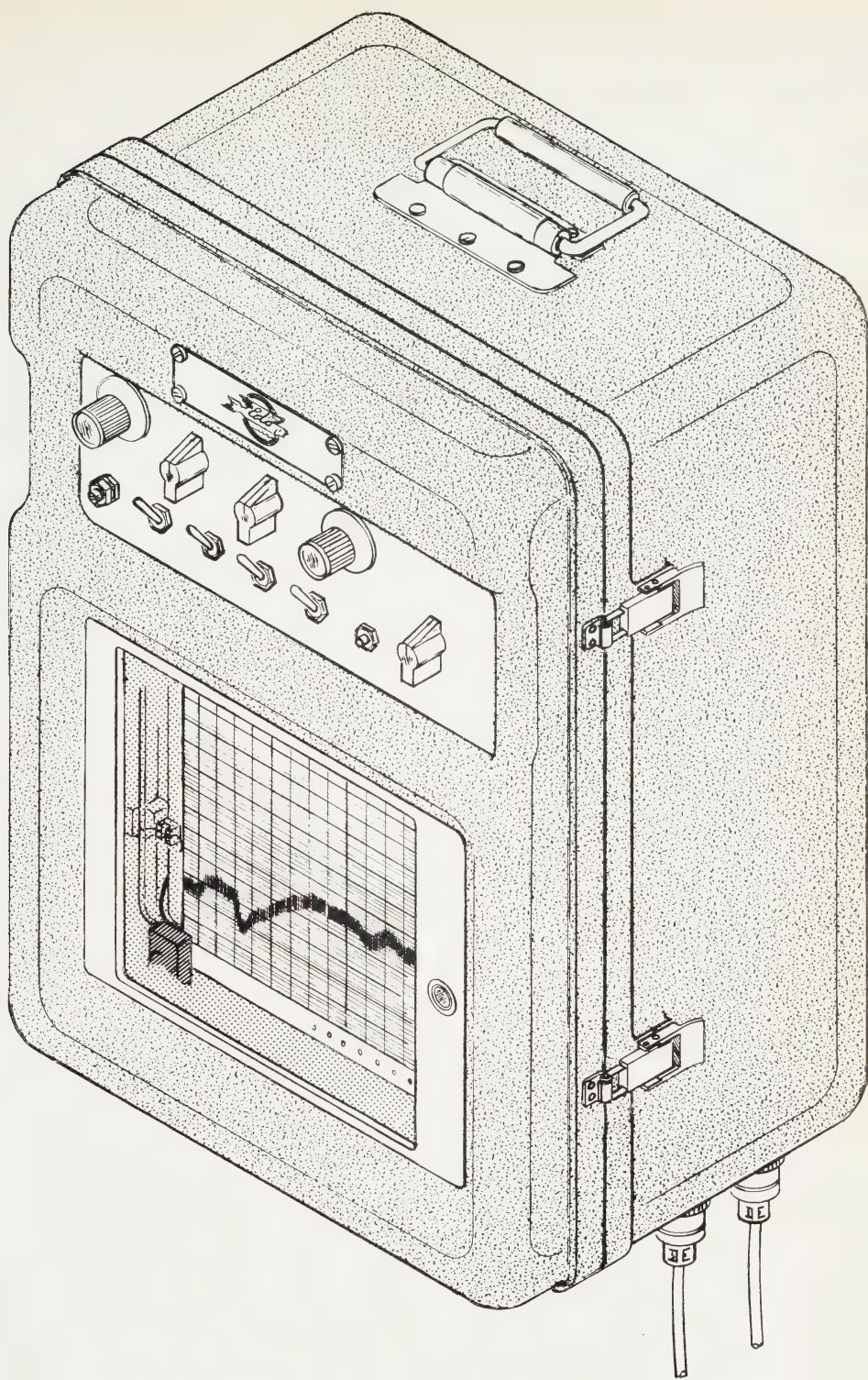


Illustration of Edo Model 9040 — Precision Depth Sounder.

## REMOTE DEPTH INDICATOR

In keeping with the trend to digital read-out equipment, a depth indicator has been developed as a remote ancillary unit for use in depth sounding systems. The Model 9046 Remote Depth Indicator is illustrated. It provides a bright digital display of water depth below the vessel in which the system is fitted. The three-digit display can be read at distances up to 27 feet (8.2m).

This Remote Depth Indicator has been designed for use with the Model 9040 described on page I-158. However, by minor changes, other indicating or recording depth sounders can be used to provide the necessary input signals. The Remote Depth Indicator accepts transmission and echo signals from the recorder. The time lapse between these signals is used to gate electronic counting circuits. The outputs of three counter decades appear as illuminated numerals on corresponding read-out tubes. Accordingly, maximum read-out is 999 feet (304.5 m) or 999 fathoms (1827 m) depending on the mode of operation selected. The numeric display is interrupted at the pulse repetition rate of the associated sounder or recorder.

The prototype unit was designed by Edo (Canada) Limited for use in the R.C.N.'s FHE — 400 hydrofoil craft. In this application, the prime requirements were: small-size, light-weight, ruggedizing against shock and vibration, and ability to withstand exposure to salt-sea atmosphere. The unit is also currently under consideration for use in the USN's Deep Submergence Program.

The case dimensions are 7" x 6" x 10" (17.8 cm x 15.3 cm x 25.4 cm). It weighs only 8 pounds (3 kg).

The internal power supply is designed to operate from a 115 volt, 400 cps supply. Operation from 60 cps power is possible by using an alternate transformer in the power supply. Power consumption is under 10 watts.

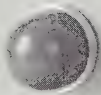
All circuits are transistorized except for the gas-filled, cold-cathode display tubes. The keying and counting circuits are mounted on removable component boards. Both front panel and internal (preset) controls are available to set up the unit for particular installation requirements.

### SPECIAL FEATURES:

1. Feet or fathoms mode of operation can be selected by a front panel control.
2. Accuracy of reading is within 1.0% plus or minus one count with the clock oscillator adjusted for the correct sound velocity.
3. Digital memory circuits retain the last reading in the event of "missed" echoes.
4. An over-depth warning lamp turns on whenever a bottom return has not registered within the range capability of the overall sounder system. (This range setting is adjustable).
5. An adjustable "draft" control enables the display to show actual water clearance below the lowest point of the hull.

The Model 9046 Remote Depth Indicator is essentially a device to measure and display elapsed time between two electrical signals. The manufacturer suggests that minor variants of the design be considered for other applications involving time measurement where the digital output will be in proportional units, not necessarily water depth.

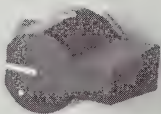




FATHOMS

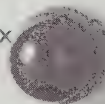


FEET

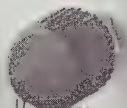


OFF

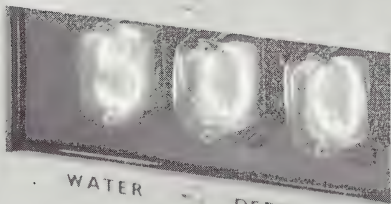
MAX



DEPTH



ILLUMINATION



WATER

DEPTH

## TRANSISTORIZED MARINE RADAR — LN55

This compact Canadian Marconi Company marine navigational radar was designed to bring the benefits of radar navigation to small craft operators without the high cost, high weight factor, high power consumption and the need for technically competent operators associated with previous radars.

The display unit measuring 15- $\frac{1}{2}$ " x 12- $\frac{1}{4}$ " x 20- $\frac{1}{2}$ " (39.4 x 31 x 52.3 cm) may be bulkhead or chart table mounted or free standing on its own pedestal. Ranges of 1, 4, 8 and 16 miles are displayed on the 10" (25.4 cm) cathode-ray tube with switchable range rings of  $\frac{1}{2}$ , 1, 2, and 2 mile intervals. The use of all solid-state circuitry and fixed coil deflection system eliminate the need for ventilation of the display cabinet permitting closed cabinet design for weather protection.

The precision slotted-waveguide antenna is enclosed in a glass-epoxy radome which provides complete protection from wind, water and icing conditions, eliminating wind drag and ice loading to keep power drain to a minimum.

The separate transmitter/receiver package can be installed in any convenient location to simplify the running of waveguide. This package contains a completely solid state receiver and regulated DC power supply as well as the 6 kilowatt transmitter. Plug-in power adaptors permit efficient change-over to 13.6, 26 or 36 volt systems. The circuitry is protected by fast-acting primary and secondary fusing. Installation and maintenance have been simplified by the use of a comprehensive system of test points and controls. At approximately 160 watts consumption the LN55 has the lowest power drain of any 10 inch (25.4 cm) radar available.

### SPECIFICATIONS

#### RECEIVER

*I.F. Bandwidth:* 5 Mc

*I.F. Center:* 30 Mc.

*Tuning:* Synchronous.

*Noise Figure:* 12 db (overall)

#### TRANSMITTER

*Peak Power Output:* 6 Kw.

*Frequency:* 9375  $\pm$  30 Mc.

*Modulator:* Line and thyratron

*Pulse Length:* 0.2  $\mu$ S

*Pulse Repetition Frequency:* 1500 pps.

#### ANTENNA

*Rotation Speed:* 22 rpm.

*Horizontal Beamwidth:* 2.5° (-3db points)

*Vertical beamwidth:* 22°

*Side Lobe Suppression:* More than 24 db.

*Type:* Precision slotted-waveguide.

*Polarization:* Horizontal.

*Radome Wind Load:* 80 knots.

*Power requirements:* approx. 160 watts at 13.6, 26.4, 36 volts DC or 115 or 220 volts AC.

*Peak power output:* 6 kw.

*Ranges:* 1, 4, 8 and 16 nautical miles.

*Calibration:*  $\pm 2\%$  of range.

*Range discrimination:* 35 yards (32 m) or better.

*Bearing accuracy:*  $\pm 1^\circ$

*Weight:* Transmitter/receiver: 37 lbs. (16.8 kg). Radome/antenna unit: 50 lbs. (22.7 kg.)

Display: 32 lbs. (14.5 kg.)





## OCEANOGRAPHIC RESEARCH WINCH SYSTEMS

The Oceanographic Winch described in this article is only one of a family of bathythermograph equipment which J. Swann (1963) Limited have designed and produced for oceanographic surveys.

The Series No. '0' — 410 is a medium duty, deep casting oceanographic winch. This unit will hold 5 miles (9.27 Km.) of 5/32" (3.97 mm) diameter wire rope and is supplied in various models with line pulls up to 1250 lbs. (567 Kg.) and line speeds up to 625 ft/min. (190.5 m/min). It is driven by a piston type hydraulic motor which was designed by this company. The motor has a constant torque characteristic over its entire operating range. For satisfactory operation the winch requires an oil delivery of 35 U.S. gpm (132.5 lit./p.m) at 1200 psi. (544.3 Kg. per 645 mm<sup>2</sup>).

Several unique features are supplied as standard equipment. The direction and line speed of the winch are both controlled by a single lever valve which was developed to meet the sensitive control requirements of this type of work. The valve is a directional, pressure compensated flow control which enables the operator to instantly vary the hauling speed to suit the conditions. The winch is fitted with an automatic hydraulic braking device which holds the load under all operating conditions. It is also fitted with a self-energizing band type manual brake which is operated by means of a handle with a ratchet release and separately by a foot pedal.

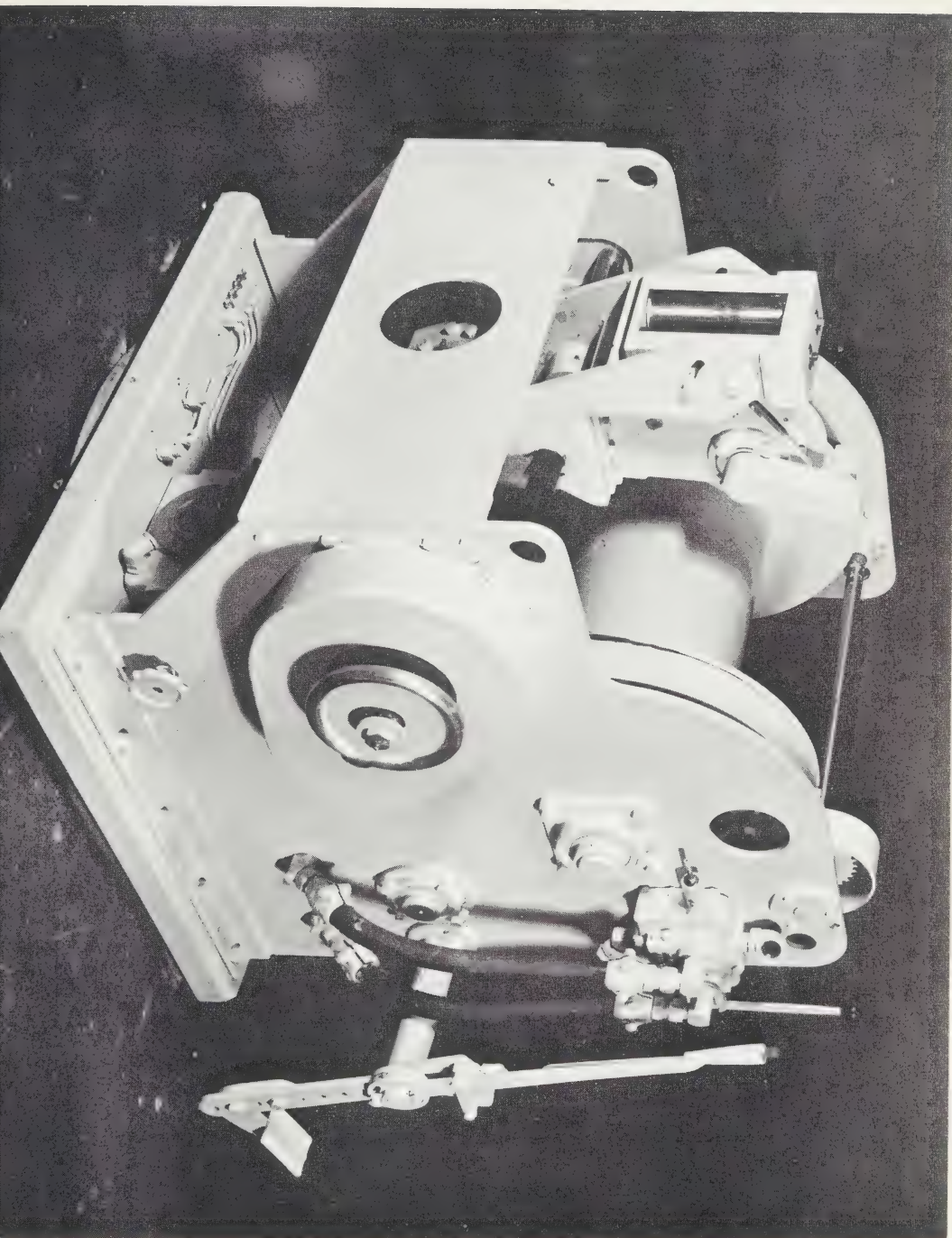
Another feature which is fitted as standard equipment is the automatic spooling arrangement. The spooling drive train is infinitely variable so that any wire size from 3/32" (2.47 mm) diameter to 1/2" (12.7 mm) diameter may be spooled onto the drum. The wire size to be used is selected by means of a small handwheel. The spooling head has two vertical hardened steel rollers which are mounted on sealed ball bearings and can be tilted to allow for a wire lead of from horizontal to 45°. The carriage is driven directly from the drum by a diamond screw and a hardened steel shuttle. It may be declutched and moved manually to suit the wire position on the drum.

Optional equipment available is:

- 1) A rotating base which enables the winch to be positioned anywhere around 360°.
- 2) A remote control unit which enables the operating position to be at the rail so that the wire entry into the water can be observed.
- 3) A maximum of ten gold-plated slip-rings for electrical pick-up can be fitted. These are of the low noise variety and allow continuous electrical readings to be made during payout and haul in operations.
- 4) A wire measuring device can be mounted on the spooling head. This consists of a wire measuring wheel which drives an electric tachometer-counter. It gives direct readings of line speed and length of wire paid out. The counter will also subtract thus showing the amount of wire remaining to be hauled and has a quick zeroing feature built into the indicator. The indicator is of the remote type and may be placed at any operating position.

The series No. '0' — 410 is one of the units from the complete line of the oceanographic equipment manufactured by J. Swann (1963) Limited. Numerous standard models are available or a custom built winch system can be designed and manufactured for any specific requirement.

This company produces a complete line of deck machinery for use on Tow Boats, Cargo and Fishing Vessels as well as Harbour Craft. Their bathythermograph winches may be found on the most modern survey vessels employed in Canada. Their deck equipment, for fishing vessels in particular, is now being exported to Europe.



# BATHYTHERMOGRAPH SLUG

The bathythermograph slug, developed and produced by E.M.I.-Cossor Electronics Ltd., provides a reliable means of obtaining the propagation speed and propagation path of sound waves in water despite temperature variations. In operation, the slug is launched from an aircraft and is dropped to water level inside a bomb-shaped container.

One minute after impact, now automatically released from the container, the slug sinks at a constant rate while a temperature-sensitive device within the unit detects changes in sea water temperature. The sensing device controls the frequency of an oscillator which in turn drives a transducer which radiates acoustic power.

A standard sonobuoy, which may have been dropped at the same time or is already in the water, is used to detect the acoustic signal from the slug. The signal modulates the output of the sonobuoy transmitter. After demodulation by the aircraft receiver, the signal is applied to a translator unit. The output from this unit drives a pen recorder which provides a direct presentation of water temperature in degrees Fahrenheit versus depth of water. The depth factor is introduced as elapsed time from the release of the slug.

The bathythermograph package falls at 225 feet per second (68.6 m/sec). The resulting impact upon hitting the surface of the sea compresses a rubber pad between the nose plate and the slug. This permits a spring-loaded latch to release. The spring is then able to ease off the nose cap and as these components fall clear, the rear section of the package, containing the slug, floats to the surface. The slug fits upside-down in the cylinder like a close-fitting piston. Water leaks into the cylinder through a small hole, permitting the slug to slide slowly downwards. After a delay of one minute, the slug falls clear. Three hinged vanes are provided which spread out as the slug leaves the cylinder. The opening of one of these vanes is slightly retarded, so that the temporary unbalanced condition causes the slug to rotate quickly to the upright position. A switch then closes the battery supply circuit and the slug commences to operate. The vanes produce a uniform sink rate of five feet per second. (1.5 m/sec.)

Electronic and electrosonic components consist of a thermistor (the temperature-sensitive device), a transistorized oscillator controlled by the thermistor, and a transducer, powered by the oscillator output. A small air chamber is located behind the transducer. This equalizes the pressure on both sides of the transducer and compensates for changing sea water pressure as the slug descends. The oscillator frequency range is 4,800 cycles per second to 6,200 cycles per second, for a temperature variation of 25°F to 95°F. (-4°C to 35°C).

Power for the electronic circuit is provided by a sea water activated battery which is entirely inert until wetted during the surface flotation phase. Use of this type of battery permits a shelf life of several years with no attention being required prior to use.

The translator unit is built in a small, standard size, shock-mounted case and operates from a 28v dc supply. The transistorized circuits are designed to minimize the effects of sea noise and multipath interference on the recorded trace. Self-calibration facilities are provided.

The bathythermograph slug was originally designed for tactical use during anti-submarine operations, however, as can be seen, it is a device of considerable value in the gathering of oceanographic data. The conventional method of obtaining temperature readings by employing ships is both slow and costly. By utilizing bathythermograph slugs dropped in conjunction with standard sonobuoys, temperature readings over large areas of ocean can be obtained in a comparatively short time.

## BATHYTHERMOGRAPH SLUG

Temperature Measuring Range	25°F to 95°F
Maximum Operating Depth	1000 ft.
Oscillator Frequency	4800 cycles per second to 6200 cycles per second
Power Output	100 milliwatts approx.
Sink Rate	5 ft. per second
Depth Accuracy	±3 ft. at 100 ft. ±12 ft. at 1000 ft.

## Temperature Accuracy—

### Normal Conditions

Water Temp.	30-70°F
Slug Ambient	
Before Launch	30-80°F

### Extreme Conditions

Water Temp.	25-95°F
Slug Ambient	
Before Launch	-5 to 120°F

## Maximum Launching Speeds

150 to 500 ft.	150 kts. max.
500 to 10 000 ft.	250 kts. max.
Weight	3.2 pounds
Package Dimensions	15 in. x 3 in.

## TRANSLATOR

Input	0.1 volts to 2.0 volts rms at 4.8 to 6.2 kilocycles
Output	0 to 1 ma. dc into 10 to 15 K ohms
Power Requirements	28 volts dc, 0.15 amps
Size	7 7/8 x 5 x 10 in.

Case in accordance with MIL-STD-91402-S1





## OCEANOGRAPHIC DATA COLLECTION INSTRUMENTATION VEHICLE

One of the major barriers to the extensions of man's knowledge of underwater phenomena, has been the difficulty of placing at sea scientific instruments to measure and record the characteristics of these phenomena. In the past, small research vessels have usually been used to obtain desired data. However, in many instances, particularly when data must be collected over a long period of time, the use of a ship is prohibitively costly.

The oceanographic vehicle described here offers a solution to this problem by providing an instrumentation platform which can be moored at sea, in depths up to 3000 fathoms (5486.4 m) and left unattended for long periods of time. The success of the E.M.I.-Cossor oceanographic vehicle is attributable mainly to the unique launching and mooring technique utilized.

For launching, the entire system is assembled into one package. Launching can be accomplished from virtually any ocean-going vessel equipped with very simple handling gear. Mooring is an entirely automatic operation; the vehicle lowers its own anchor, locks the anchor cable into position, and turns itself on, all on a pre-programmed basis.

The vehicle is used to collect information on underwater acoustic disturbances, and to transmit this information by radio. It consists mainly of three groups of components; a surface group, containing the electronics and power pack; a subsurface group consisting of the subsurface float, data collecting instrument and automatic depth setting unit; and the anchor and mooring cable group.

The Surface Unit is designed to offer minimum resistance to wind and current. The unit also houses the antenna, power source and electronics. The Subsurface Float has been carefully designed and tested to offer a stable platform for underwater instruments. It is essentially a welded steel tank, pressurized to equal the surrounding water pressure. The Automatic Depth Setting Unit comprises a drum which stores the mooring cable, and a hydraulically controlled brake. The brake prevents the drum from unwinding the mooring cable until the predetermined subsurface float depth has been reached. The entire subsurface group of components is attached to the surface group by means of the upper mooring and data transmission cable. The Lower Mooring Cable is  $\frac{1}{8}$  inch diameter (.3 cm) steel wire rope, which terminates in an insulator to prevent electrolytic corrosion. The insulator is connected to the cast steel anchor through a length of chain and a ball-bearing swivel.

The launching of the vehicle is an almost entirely automatic operation. The buoy is delivered to the User as a rigid, self-contained package. In mooring the buoy it is merely necessary to launch the complete package. The mooring then proceeds automatically and is complete within 45 minutes. Two minutes after the completion of the mooring the winch locks itself automatically and permanently.

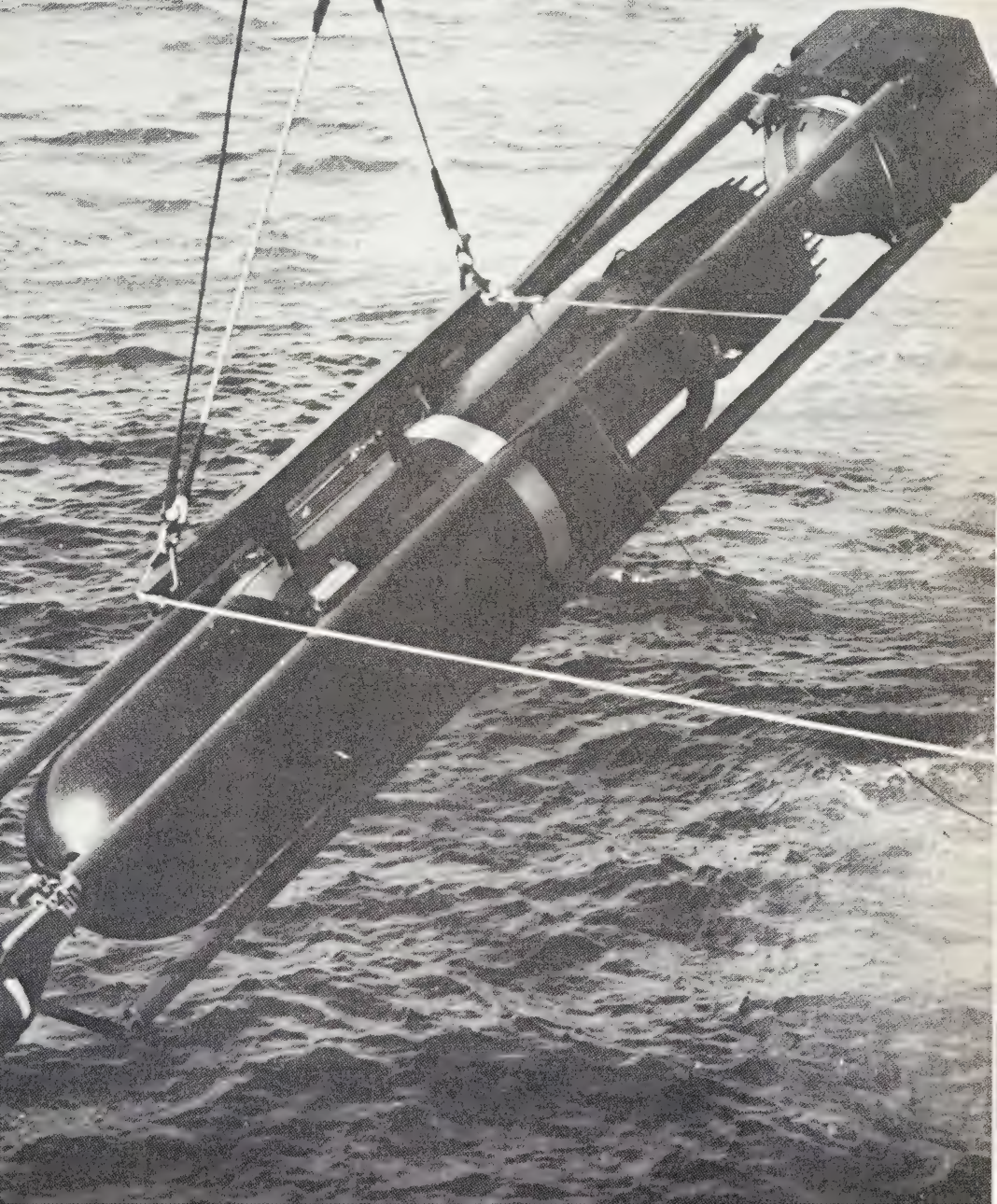
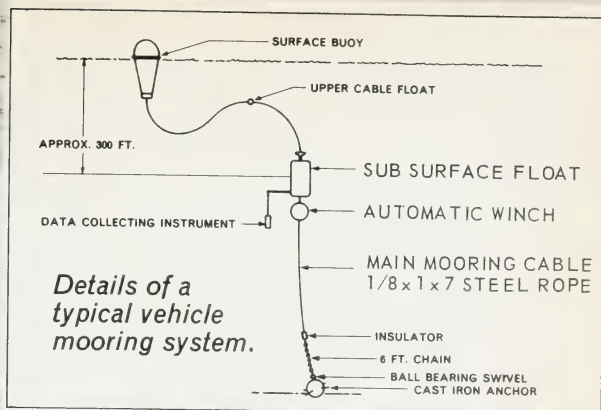
The applications of the vehicle are limited only by the ingenuity exercised in the design of the payload. When fitted with suitable instrumentation and electronics, data on almost any characteristic of the sea can be gathered. By using more than one vehicle, simultaneous data can be gathered from any desired number of locations. A less sophisticated application of the vehicle is its use as a permanent position marker. In this role it simply transmits a continuous signal thereby enabling it to be easily located by radio direction finders.

E.M.I.-Cossor Electronics Ltd. has supplied several configurations of the vehicle to organizations and agencies engaged in oceanographic research. The buoys have been supplied completely equipped with the particular electronics and instrumentation required.

Some specific applications have required modification of the basic system. However, the design of the vehicle allows it to satisfy a wide variety of requirements.

E.M.I.-Cossor engineering and scientific personnel are available to discuss with your organization the application and adaptation of the vehicle to your specific requirements.







## PLASTIC GUN SHIELDS

In 1953 the Royal Canadian Navy decided to initiate and guide a design and development programme to produce a 3"/50 gun shield in a plastic material. Such a plastic structure was unique at that time. An aluminum shield was also considered before this decision was reached. The material selected was that of a polyester, resin reinforced fibreglass with non-inflammable characteristics which was preferred due to its shape-forming capabilities, composition and structural features as it provided a better strength/weight ratio than could be obtained with an aluminum structure. It also met a design requirement in which the material itself needed little maintenance.

The primary purpose of such a shield is to afford the fullest possible protection of the armament from the adverse effects of a marine environment, thereby considerably reducing the maintenance requirements of the 3"/50 Twin Armament.

An early prototype "guinea-pig" shield was first constructed to establish suitable fabrication processes for the production of fibreglass mouldings in the required shapes and sizes and to enable actual strength characteristics to be physically determined. This work proved the overall feasibility of constructing a suitable fibreglass shield and paved the way for pre-production models to be built by Uniroyal (1966) Limited. These models embodied certain design changes and improved manufacturing techniques and underwent sea-going trials in HMC Ships OTTAWA and SAGUENAY in 1956 and 1958. With the design now firm the company then commenced production models which were supplied to this class on refit programmes.

The shield is equipped with access doors for the crew members and ammunition handling, heating units, de-icing units and fume-exhaust fan motors fitted with flexible trunking. The shield completely encases the armament proper and provides obvious improvements to the habitability of the shield at all times. Colouring pigments, introduced as required during the initial fabrication work, effect a reduction in future painting requirements. The eight major sections of the shield are supported by a fibreglass platform assembly which is secured to the base structure of the mount. Watertight access ports are also incorporated to enable various operational checks and adjustments to be carried out on the armament.

So far as is known no other navy, until recent times, has devised a gun shield comparable with that which has now been in regular Royal Canadian Navy service since 1956.

This singular experience gained by Uniroyal Ltd. has left them in the position to design and develop other structures of this type and to the exacting demands of naval requirements.



## FORGED STEEL VALVES AND STEAM TRAPS

Velan Engineering Companies are manufacturers of one of the most comprehensive ranges of forged and cast steel valves and steam traps used throughout North American Industry as well as in Naval vessel and Military establishments.

The company's range of valves can be divided into seven basic categories:

- Small —  $\frac{1}{4}$ " — 2" (.6 — 5.1 cm) Forged Steel Bolted Bonnet Gate, Globe and Check valves utilized in general industry from low through high pressure service.
- $\frac{1}{4}$ " — 3" (.6 — 7.6 cm) Forged Steel Bonnetless Gate, Globe and Check valves for power and high pressure service.
- Large Cast Steel valves from 2" — 24" (5.1 — 61 cm)
- Large Forged Steel "Pressure-Seal" valves from 2" — 16" (5.1 — 40.6) for general industrial and high pressure power service.
- Stainless Steel valves both cast and forged in the complete range from  $\frac{1}{4}$ " — 24" (.6 — 61 cm) for corrosive services.
- Top Entry and Side Entry Ball valves in the complete range from  $\frac{1}{4}$ " — 16" (.6 — 40.6 cm).
- Special service custom built valves redesigned and engineered by modifying existing designs and completely custom built valves designed, engineered and manufactured from the ground up.

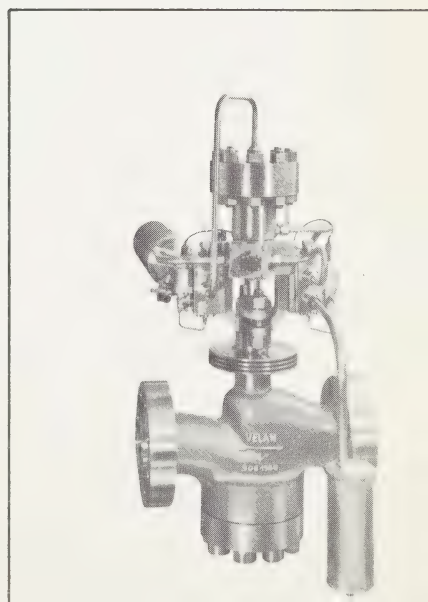
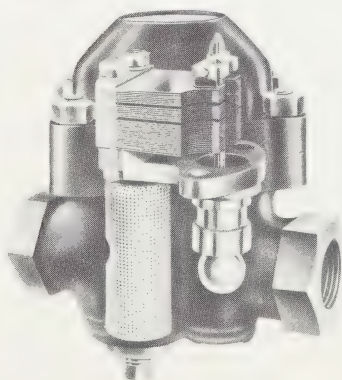
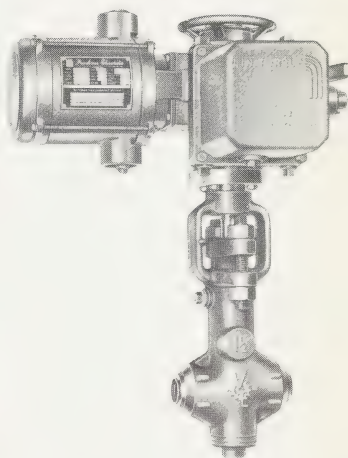
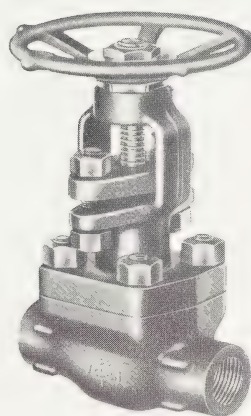
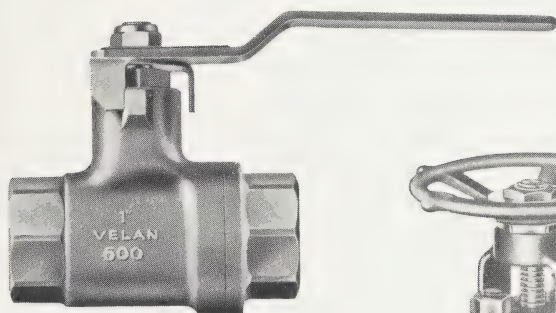
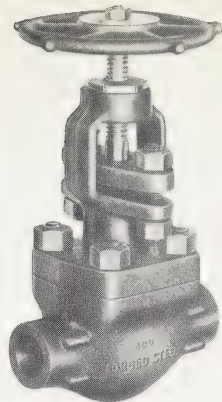
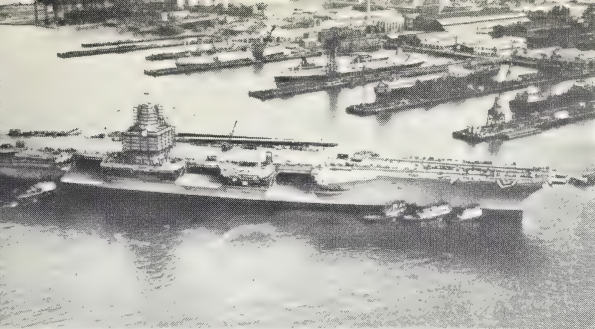
In this last category, valves for such exotic services as Nuclear Power, Cryogenic and Rocketry, are manufactured. Typical examples of the company's products are shown on the accompanying page together with the first U.S.N. Nuclear Carrier "U.S.S. Enterprise" which was, along with its sister ship, equipped with Velan valves and steam traps. Bottom right is one of three custom-built nuclear control valves built to special specifications for the NERVA nuclear rocket to be used for landing U.S. Astronauts on the moon.

Velan Engineering is located in Montreal with excellent raw material, manpower, rail, road, sea and air transportation facilities. To cater for its growing business in the United States, the company operates two independent U.S. Corporations located in upper New York State where the complete range of products is manufactured, supplemented by the engineering, designing and manufacturing facilities of its main plant in Montreal.

Excellent U.S. Sales and Service facilities are provided through the company's branch sales and service offices in New York City, Houston, Chicago and Los Angeles augmented by associated agents, distributors and representatives in major U.S. cities.

As the company operates a plant in England and has sales and service facilities throughout the world, these facilities are always at the service of U.S. industrial and defence commitments abroad, offering replacements, spare parts and servicing in any part of the globe.





## LENSES FOR AIR RECONNAISSANCE CAMERAS

The picture on the facing page illustrates a group of lenses that have been developed and manufactured recently by Ernst Leitz Canada Limited for the RCAF, the United States Military Services, as well as a number of NATO countries.

Using the knowledge gained from the development of high precision photographic lenses for 35 mm cameras, the company approximately 5 years ago started research work on lenses covering larger formats. The VICOM system for the 70 mm format which is installed in the CF-104 aircraft of the RCAF was the first reconnaissance system to utilize these new lenses. The present range of lenses covers the following focal lengths and apertures:

1¾"	f/2.8
3"	f/2
6"	f/2.8
6"	f/2.4
12"	f/4
24"	f/4

This group gives an angular coverage from  $7.5^\circ$  (24") to  $90^\circ$  (1¾"). The 24" lens is an apochromate and the designer made use of the latest developments of new optical glass. As the lenses are used with filters they are designed for optimum performance in the spectral range of  $486.1 \text{ m}/\mu$  to  $656.3 \text{ m}/\mu$ . The 24", however, is also achromatized for  $768.2 \text{ m}/\mu$ .

Besides lenses for the 70 mm format a group was also designed and made for cameras having the  $4\frac{1}{2}" \times 4\frac{1}{2}"$  format. These lenses have the following technical specification:

6"	f/2.8
12"	f/4
18"	f/4
24"	f/4

In addition to designing and manufacturing lenses for air reconnaissance cameras the company is also engaged in the development and manufacture of optical fire control instruments, infrared optics and special lenses for plotting tables, CRT photography, micro recording and projection equipment as well as data processing equipment.

This same firm has produced the Sightunit C2; Telescope, Sniper C1; a family of Aerial Reconnaissance Lenses as well as a Gas Laser and these items are reviewed in this section of the book.





## OPTICAL-MECHANICAL FIRE CONTROL

The effectiveness of any weapon system can be denominated by the accuracy and simplicity of the fire control element. The reliability of the weaponry may be measured by the ruggedness designed into the precision instrument and the degree of ease associated with maintenance. Availability of the fire control element may be influenced by cost and excessive costs may well preclude the acquisition of an equipment which could take full advantage of the inherent capabilities of the weapon.

Canadian problems in this area were largely solved when Ernst Leitz Canada Ltd. was established in 1952. This firm has provided Canada and the Canadian Forces with a facility equal to any in North America and personnel with production and design backgrounds trained to the exacting standards demanded by their predominant product — the Leica Camera.

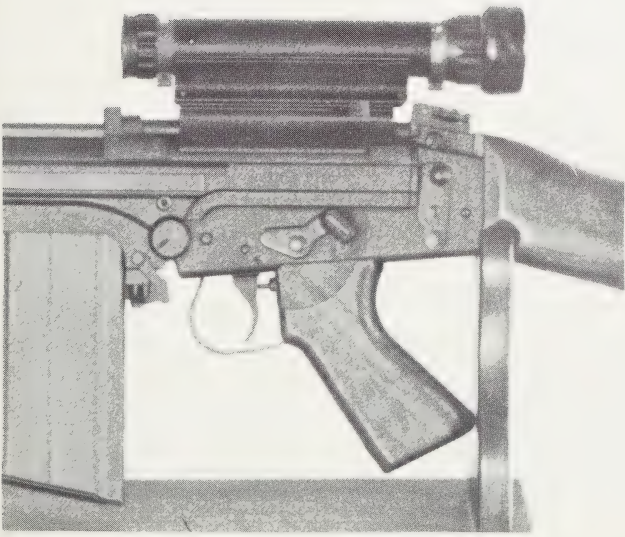
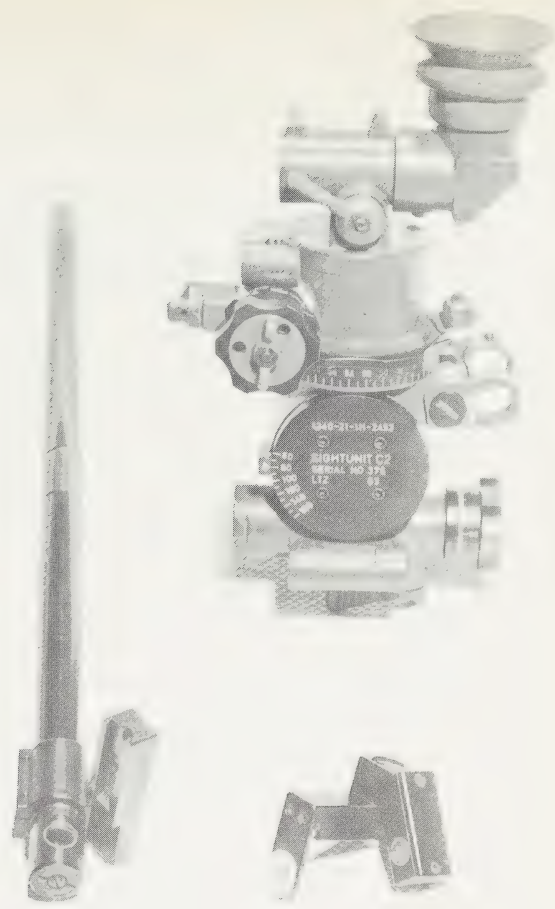
Leitz equipments have found acceptance in allied nations around the world in commercial and military fields where both competition and performance requirements present a restricted field. Some of the more basic and interesting products are noted below.

The Sightunit C2 was designed to replace other older Sights such as the M4, M6 and M34A2 which did not meet user requirements. The new equipment had to serve improved fire control systems and procedures as well as be capable of taking the heavier shocks imposed by newer and more powerful mortars. At the same time the Sight had to provide greater accuracies than the older equipments to take full advantage of greater ranges. All Scales are in mils and the accuracy to lay is true in Azimuth and Elevation to within  $\pm 2$  mils. The Sight has been designed so that it is capable of being tested and adjusted by unit personnel to ensure proper alliance with the bore axis of the weapon. The Sight weighs only 2.8 lbs. (1.3 kg) and has passed all trials for shock, immersion, drop, temperature, etc. Ancillaries exist which permit an elevated line of sight as well as a light projection device for use with a paralleloscope when the weapon is employed in a deep pit or APC where an outside aiming post is not possible. This equipment has been adopted by U.K., Australia, New Zealand, India as well as being on trial in several other countries.

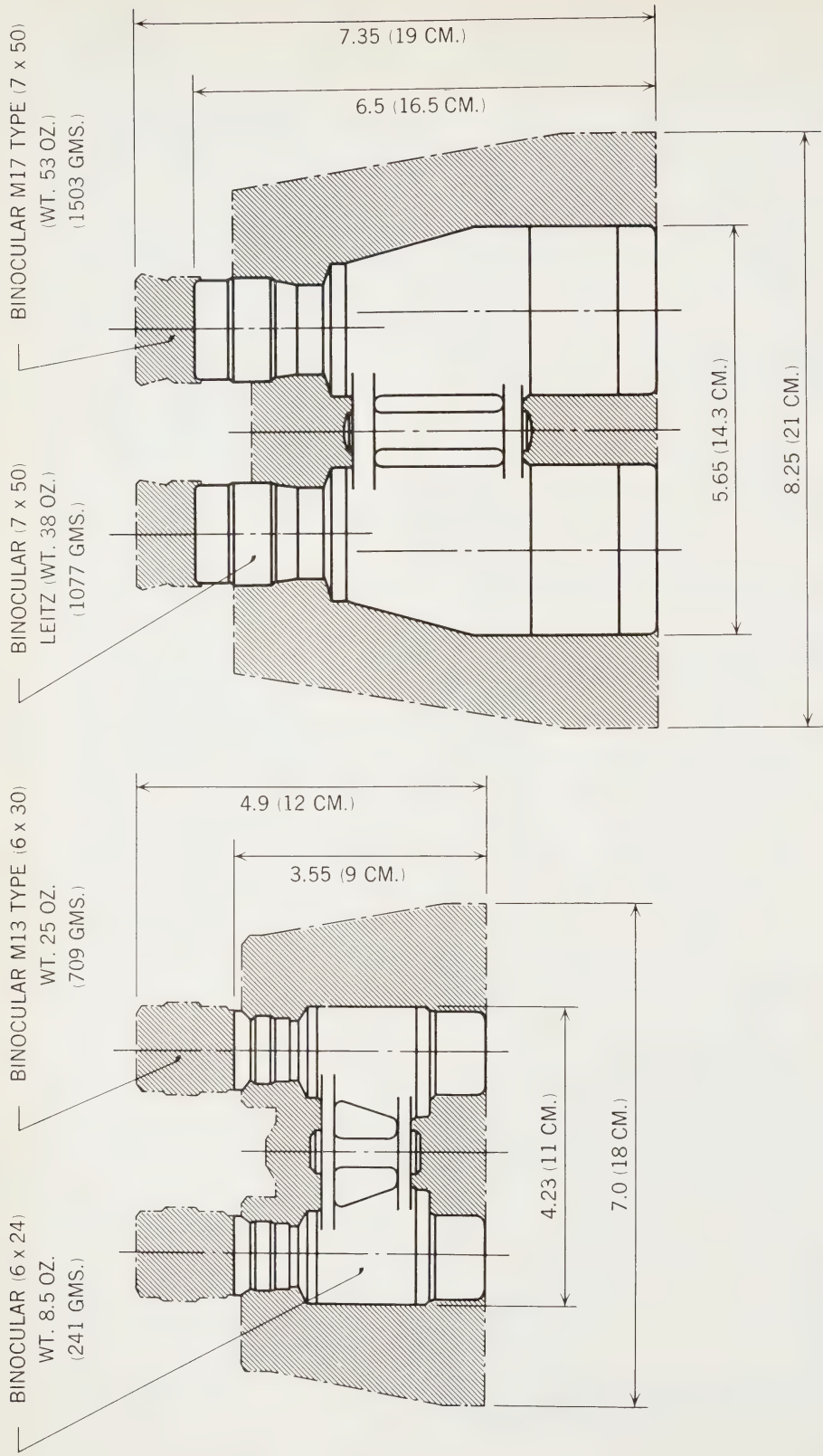
When the Canadian Army adopted the FN Rifle they were left with the choice of accepting existing Sniper Telescopes, as is the usual practice, or providing a Scope which was designed for the rifle and that met the particular ballistics of that rifle. Fortunately they chose the latter course and Ernst Leitz Canada designed, developed and produced a sight which offers many distinct advantages over other known models. The basic design accommodates the FN Rifle or rifles of that type but the scope can be used with any rifle by changing the mount facilities. The Telescope has a length of 8" (203 mm) and a tube diameter of 1" (25.4 mm) and weighs only 10 oz. (.28 kg) including the mount. It has a magnification of 4 $\times$  and a field of view of 90 mils. The Telescope Mount is fixed to the rear cover of the rifle and employs a unique shock mount device which provides instantaneous mounting or dismounting of the telescope, as the rifle changes roles, yet still maintains its zero. In range the reticle is elevated or depressed by rotating the eyepiece mount and adjustments are in  $\frac{1}{2}$  mil clicks from 100 yards to 1000 yards (91.4 to 914 m) with an additional reticle movement of 6 mils to allow for zeroing. In deflection the reticle is moved laterally by rotating the objective mount which again is adjustable in  $\frac{1}{2}$  mil clicks with 6 mils provided for zeroing. The deflection slipping scale is graduated in mils and provides 5 mils left and 5 mils right of center.

To meet a requirement for an inexpensive day-night rifle sight Leitz has developed a light-weight unit power reflecting telescope type of day-night sight that, although short in length and simple in construction, is capable of projecting a reticle to infinity on which to align a target. This is accomplished by providing a real intermediate image of the target on a mirror in which a reticle is located. Night use becomes possible by illuminating this etched reticle with a Trilux light source thereby

SIGHTUNIT C-2 AND ELE-  
VATED LINE-OF-SIGHT AN-  
CILLARIES.



TELESCOPE, SNIPER C-1.



PART OF FAMILY OF LIGHTWEIGHT BINOCULARS



eliminating batteries. A control is provided for reticle illumination adjustment.

The sight optical members are cemented to the ends of a triangular prism which eliminates internal air glass surfaces. This optical system is enclosed in a metal case which incorporates elevation and azimuth adjustments and this case is in turn mounted on the rear cover of the FN rifle. Other adapter mounts can be provided if desired.

During day use the reticle is dark against the bright background but at night it is light against the dark background.

Anyone who has been concerned with repair and maintenance of binoculars for Services would doubtlessly agree that due to an inherent long life there tends to be a multitude of types and makes with an ensuing logistic problem for spares and repair techniques. This company has designed a family of light-weight binoculars which is of considerable interest. In the small sizes, 5 x 20 and 6 x 24, a new prismatic erecting system is used which provides equal inter-objective and inter-pupillar distances. This allows the two halves of the main body to be designed to accept identical erecting systems thus permitting modern maintenance methods as well as economical manufacture. Both glasses have the same eyepiece and differ only in the objective lenses therefore special requirements by the user could be very easily satisfied.

A special binocular, 5 x 35, for observation, from moving vehicles such as aircraft, landing craft, tanks, etc. has been provided with a relatively large exit pupil (7 mm) and low magnification which provides considerable improvement over all present types now available for this purpose.

The 7 x 50 has been redesigned into the light-weight class. Design studies have shown that the larger glasses, including the special 5 x 35, can be produced by using one standard main body changing only the eyepieces and objectives which, of course, would bring about great savings in cost and maintenance. All of this family will meet the standard military requirements of MIL-E-5272A and optical requirements are covered by JAN-G-174 and MIL-O-13830.

## **PRESSURE DOME WATER CONTACT LENS**

To meet a requirement for a photographic lens specifically designed to provide the optimum photographic image in a sea water environment, a water contact lens has been designed and manufactured. It is an f2.8 lens covering the 70mm format and having an acceptance angle of 65 degrees. The front element of the lens has been designed so that it is used as the pressure dome window of the camera enclosure thus eliminating an air to glass and a glass to sea water surface in the optical system. This front element also is designed to withstand the water pressure at a depth of 250 feet (76.2 m). The iris control is on the external surface and provides adjustment through a suitable packing gland. Focusing is also accomplished by means of a similar control which has a focusing range of 18 inches to 20 feet (45.7 to 609.6 cm).

Using the same technique, other lenses are being designed by Ernst Leitz, Canada, for use with the 16mm and 70mm format.

## TRAINING AIDS AND SIMULATORS

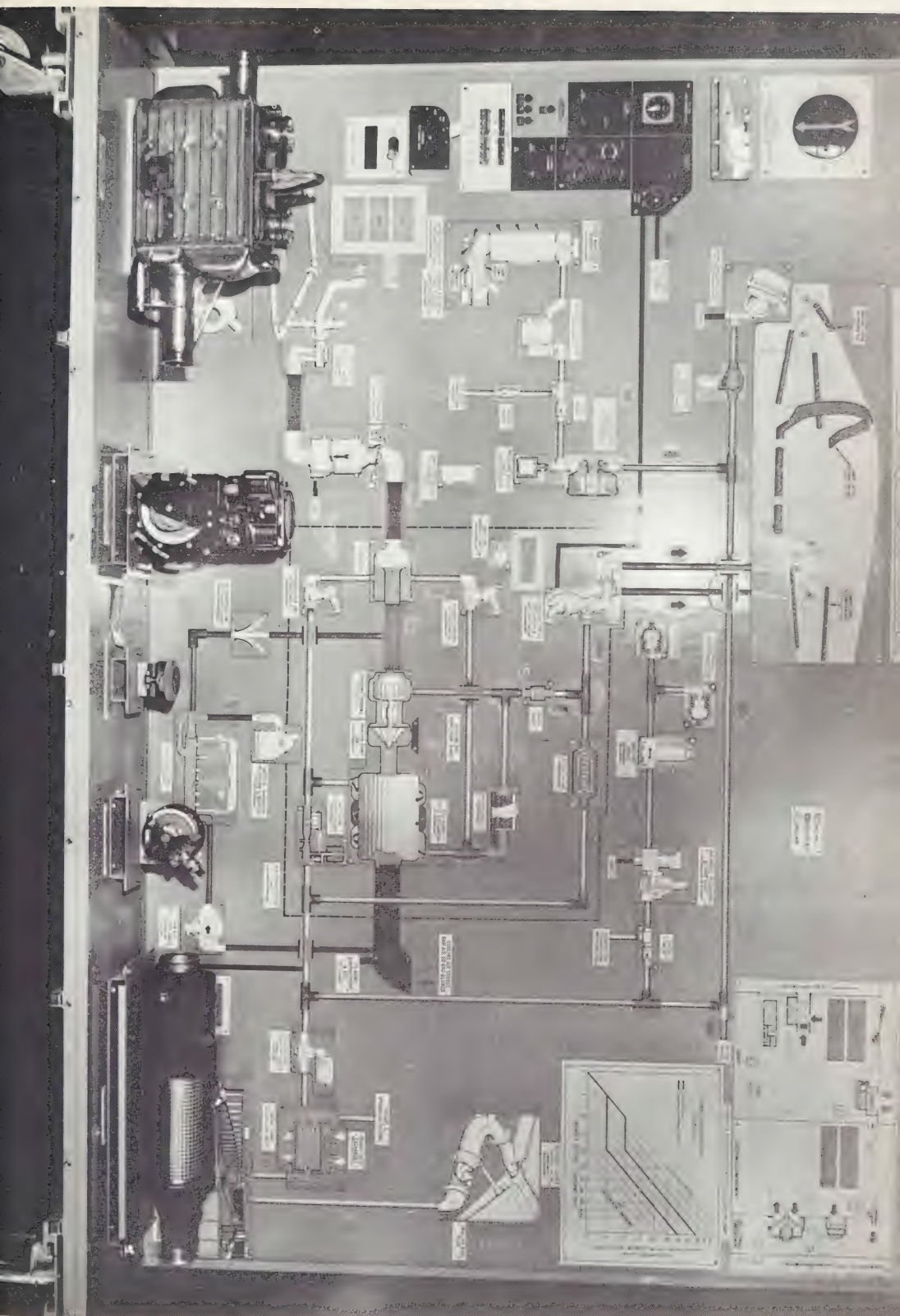
The training of personnel in the function and proper use of new equipments has always been a problem, largely due to the high costs involved in operating the actual equipment. A further consideration is the possibility of damage to the unit or injury to the trainee operator.

To-day even the most simple of equipments are becoming more complex and consequently more expensive, yet due to their complexity the need for training is greater than ever. System diagrams will no longer suffice for instruction. What is required is a device which faithfully represents the actual functioning equipment, and where applicable, be capable of reproducing malfunctions on command.

It may seem paradoxical, that such trainers, intended to save time or funds, may not be purchased due to their high cost when produced from a source with no previous experience. Fleet Manufacturing Limited have produced many of these devices and their experience in this field alone leaves them in a position to act as a consultant or design agent or if required, produce the actual equipment to meet your needs.

In some of the trainers, three of which are depicted here, cold cathode tubes are used to represent hydraulic or electrical lines and they can be colour coded, if applicable to the actual equipment. In all cases components are sectioned so that internal function can be observed.

Discussion of similar problems with Fleet Manufacturing will result in years of experience being applied to their solution.





## CUSTOM MACHINE SHOPS

One of the lesser known strengths of Canadian Industry is a small but select collection of custom machine shops that are capable of endeavours not normally found in a straight machine shop. Such firms add immeasurably to Canada's industrial make-up and the variety of products covered by some of them may be noted in this selection offered by Universal Die & Tool Mfg. Ltd.

The "hard core" of machined parts for to-day's sub and supersonic aircraft continue to exert demands on production sources for the ultimate in skills, techniques and machine tools.

The picture on the facing page is representative of the type of structural component produced by this firm for the aircraft industry. They have produced such components for nearly all Canadian built aircraft since 1946. One of these, the Spar Caps for the DC9, 108" (274 cm) in length and starting off as a 350 lb. (158.8 kg) forging and finishing as a 75 lb. (34 kg) finished machined component, has been in quantity production for some 16 months and will remain so for quite some time to come. Below the Spar Cap is a structural member for the supersonic F 104 which incorporates a homogeneous continuous hinge.

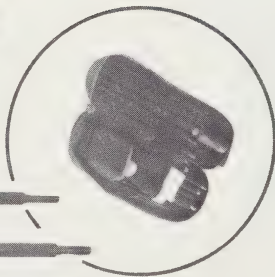
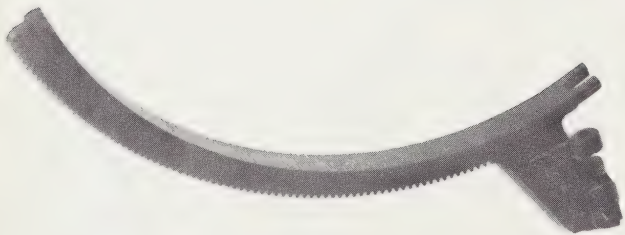
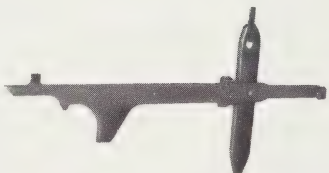
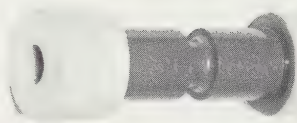
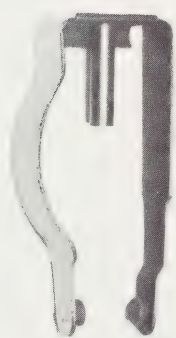
The lower photograph on the facing page is a sampling of the smaller range of ordnance items produced. They include a Small Arms Universal Cleaning Kit at "A", Blank Firing Attachments for rifles and sub-machine guns at "B", a Tension Bar for steam aircraft catapults at "C", a Maintenance Tool for automatic rifles and a gear toothed Sight Quadrant at "D". The 3 piece steel Cleaning Rod at "E" is one part of the larger kit in the inset.

These two Cleaning Kits are considered capable of cleaning and maintaining any equipment from a hand weapon (pistol) to a .5 machine gun, including shot-guns, by merely changing the accessory brushes which screw onto the Pullthrough or Cleaning Rod. The two kits have been designed as a family and common parts are used throughout with each and every weapon receiving its own individual attention. Due to these features ordnance spares are greatly reduced and at the same time the cost of the overall item is kept low as it is now used in quantity across a family of weapons as opposed to individual items for each separate weapon.

Universal Die & Tool have also produced Drill Rounds and Sub-calibre Devices for recoilless rifles, Rifle Grenade Launchers as well as Electro-Mechanical Target Devices for musketry training.

Firms of this type, in Canadian Industry, can usually be relied upon to provide a high degree of personal attention to an exacting production problem and yet, because of their smaller size, maintain reasonable and acceptable costs.







## PAPER, CHEMICAL AGENT DETECTOR

The Canadian Army has developed a simple and rapid method of detecting the presence of the three major classes of chemical warfare agents and differentiating between them. This piece of equipment is in fact a booklet whose size is  $2.5 \times 4$  in. ( $6.4 \times 10.2$  cm) and contains 12 sheets of detector paper which are perforated for easy removal when required.

The chemical agent detector is made from a reasonably strong paper. It has good wet strength and is stable in storage when kept dry and away from sunlight. The paper is loaded with three water insoluble dyes to permit detection of and differentiation between G, H and V agents.

Each agent class dissolves one of the dyes to produce a distinctive stain on the paper. G agents produce colours which vary from yellow to orange. H agents produce a red colour, and V agents produce colours which vary from very dark blue-green to light blue-green. The variations in colours produced depend on the particular G or V agent encountered. The inside of the front cover of the booklet has three panels which show the colours produced by G, H and V agents and bears the legend: **"Detects Liquids Only"**.

The paper will not change colour with water, gasoline, motor oil, grease or antifreeze.

Decontaminating Agent CI will cause a colour change in the paper. The colour produced by this agent is black but with large drops a brown colour may be seen in the centre of this black spot.

In detecting liquid chemical agents such as falling drops or splash from chemical munitions, the detector paper is exposed on the clothing or on unscreened surfaces. Where an area is suspected of liquid contamination, the paper is pressed or rubbed over the suspected surface such as grass, broad leaves, etc. Following this action, if coloured spots or streaks appear on the paper the troops immediately don their protective masks. The spots or streaks may then be compared with the colour panel provided and the matching colour determines the agent being used.

The equipment is cheap to produce and individual issue is, therefore, possible.

## **RADIACMETER, GAMMA SURVEY, LOW RANGE, IM-5016/PD**

The Radiacmeter, Gamma Survey, Low Range, IM-5016/PD is a portable geiger tube type instrument designed to measure gamma dose rate over the ranges 0 to 100 mr/hr and 0.1 to 10 r/hr. It is for use at sub-unit level for reconnoitering radioactive contaminated areas, for detecting and measuring radioactive contamination on personnel and equipment, and for training personnel in the operation of dose rate meters. The size of the prototype model is approximately 8½ in. x 4¾ in. x 4½ in. (22.5 cm. x 11.1 cm. x 11.4 cm.) and it weighs 3½ lbs. (1.6 kg).

The radiacmeter possesses the full range of characteristics of ruggedness and environmental performance for military equipment. It meets the draft operational characteristics given at Appendix 4 to Annex to the AC/196-WP/59 subject to the following comments:

- (a) It does not measure beta radiation;
- (b) The advanced circuit design obviates the requirement for a zero check and zero adjust found in older units;
- (c) It is designed with a response time of from 3½ to 4 seconds in order to reduce meter needle oscillation in low dose rate fields. The proposed required response time of one second is not considered realistic;
- (d) Although it can be used in the vehicle borne role it is not practicable to adapt it to use the vehicle power supply;
- (e) The full range of 0.1 to 500 r/hr requires two instruments:
  - 0.1 to 10 r/hr — Radiacmeter, Gamma Survey, Low Range, IM-5015/PD;
  - 1.0 to 500 r/hr — Radiacmeter, Gamma Survey, IM-108B/PD.

Pre-operating instructions are included on the radiacmeter identification plate. Each radiacmeter is provided with a webbing shoulder strap to facilitate carriage.

Testing of prototype models has been carried out and results published in Canadian Army Engineering Report AEEEE-25, Jan 64, "Radiacmeter, Gamma Survey, Low Range, IM-5016/PD (Model XP-1 to XP-4)". Tests corresponding to operational and technical requirements are included in the specification.

The production specification is CA-R-236: Radiacmeter, Gamma Survey, Low Range, IM-5016/PD. This radiacmeter has been adopted for use by the Canadian Forces.

## **RADIACMETER, GAMMA SURVEY, IM-108B/PD**

The Radiacmeter, Gamma Survey, IM-108B/PD is a Canadian modified version of the US designed Radiacmeter, Gamma Survey IM-108/PD. It measures gamma dose rate over the range 1.0 to 500 r/hr and is for use at sub-unit level for reconnoitering radioactive contaminated areas. Its size is 6¾ in. x 4¼ in. x 4½ in. (17.2 cm. x 10.8 cm. x 11.4 cm.) and it weighs 4 lbs. (1.8 kg).

The radiacmeter contains a hermetically sealed chamber and possesses the full range of characteristics of ruggedness and environmental performance for military equipment. It meets the draft operational characteristics given at Appendix 4 to the Annex to AC/196-WP/59 subject to the following comments:

- (a) It does not measure beta radiation;
- (b) Although it can be used in the vehicle borne role it is not practicable to adapt it to use the vehicle power supply;
- (c) The full range of 0.1 to 500 r/hr requires two instruments:
  - 0.1 to 10 r/hr — Radiacmeter, Gamma Survey, Low Range, IM-5016/PD;
  - 1.0 to 500 r/hr — Radiacmeter, Gamma IM-108B/PD.

Operating instructions are included on the radiacmeter identification plate. Each radiacmeter is provided with a fabric carrying case containing a belt loop and shoulder strap to facilitate carriage.

Tests corresponding to operational and technical requirements are included in the specification. The results of the production approval tests on pre-production models are contained in Canadian Army Engineering Report AEEEE-29, Feb 64, "Production Approval Testing of Radiacmeter, Gamma Survey IM-108B/PD".

The current production specification is CA-N-118: Radiacmeter, Gamma Survey, IM-108(B)/PD. This radiacmeter has been adopted for use by the Canadian Forces and has been produced in large quantities with satisfactory quality control according to the specification.





## ELECTROSTATIC DOSIMETERS

**TACTICAL:** Radiacmeter, Tactical Dosimeter, (0-600 r) IM-5013/PD.

**RESIDUAL:** Radiacmeter, Technical Dosimeter, (0-10 r) IM-5002A/PD.

**SPECIAL:** Radiacmeter, Technical Dosimeter, (0-500 mr) IM-5006A/PD.

These dosimeters are direct reading instruments for measuring up to their maximum range the total dose of gamma radiation to which they are exposed. They consist of a quartz fibre electroscope and an optical system contained in a tube which is similar in appearance to a fountain pen, and are read by looking through them longitudinally at a source of light. They are 4-13/32 in. (11.2 cm) long, 17/32 in. (1.4 cm) in diameter, and weigh 1-1/4 oz. (35.0 gms). They can be re-zeroed by means of the Charger Radiac Detector PP-5120-PD.

The IM-5013/PD dosimeter is for use by officers and NCOs for measuring prompt and residual gamma radiation as an indicator of the dose received in a local area. The IM-5002A/PD (0-10 r) dosimeter is primarily for use by reconnaissance, monitoring, and decontaminating parties. The IM-5006A/PD (0-500 mr) dosimeter is for use by instructors, and technicians for training and special purposes.

The dosimeters are hermetically sealed instruments with the full range of characteristics of ruggedness and environmental performance for military equipment. They meet the draft operational characteristics given at Appendices 2, 3 and 11 to the Annex to AC/196-WP/59 subject to the following comments:

- They do not measure neutrons;
- Energy response testing has only been carried out between 90 kev and 1.2 mev;
- Saturation occurs at ultra high dose rates (eg  $10^4$  rad per microsecond) of mixed gamma radiation and neutrons;
- The leakage rate is approximately 2 to 3 percent per day of full scale reading;
- An off-scale reading can be artificially created without leaving detectable evidence;
- The scale is in "r" rather than "rad".

Operating Instructions are supplied with each dosimeter.

A continuing programme of testing samples drawn from stock of each type of dosimeter has been initiated to determine the effect of age on performance.

These dosimeters have been adopted for use by the Canadian Forces.

### CHARGER, RADIAC DETECTOR, PP5120/PD

The Charger, Radiac Detector, PP5120/PD is for zeroing the above electrostatic dosimeters. It is basically a lightweight transistorized dc power supply operating from a single "D" cell dry battery. Its size is 4-1/2 in. x 3-3/4 in. x 1-7/8 in. (11.4 cm x 9.5 cm x 4.8 cm) and it weighs 1-1/2 lbs (0.7 kg.).

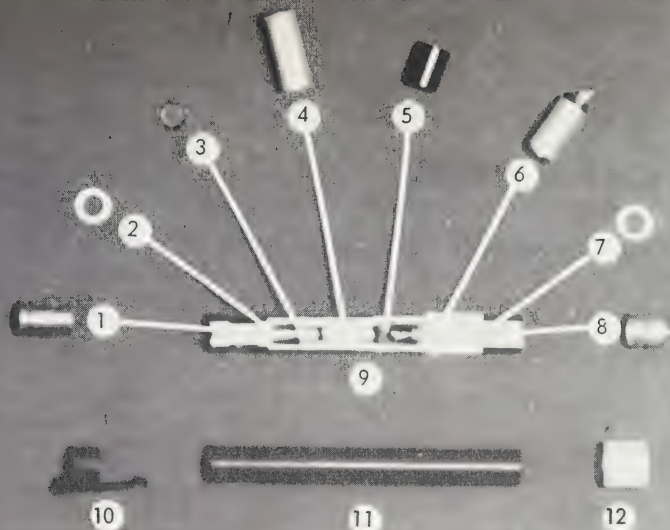
The charger possesses the full range of military characteristics of ruggedness and environmental performance. It substantially meets the draft operational characteristics given in AC/196(WP4)D/3.

Operating Instructions are included with the charger.

The charger is provided with a fabric carrying case containing a belt loop and shoulder strap to facilitate carriage.

Tests corresponding to operational and technical requirements are included in the specification.

This charger has been adopted for use by the Canadian Forces and has been produced in large quantities with satisfactory quality control according to the specification.



- |                             |                        |
|-----------------------------|------------------------|
| 1 - EYE PIECE               | 7 - LOWER WASHER       |
| 2 - UPPER WASHER            | 8 - BELLWS             |
| 3 - STAR WASHER             | 9 - CUT-AWAY VIEW      |
| 4 - OBJECTIVE LENS          | 10 - CLIP              |
| 5 - CHAMBER                 | 11 - BARREL            |
| 6 - CONDENSER, ELECTROMETER | 12 - PLASTIC PROTECTOR |



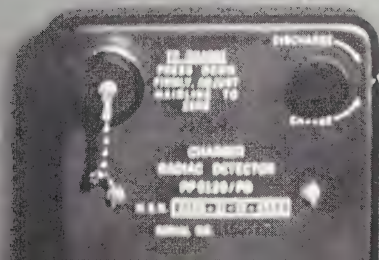
A



B



C



## RADIACMETER REMOTE MONITORING SINGLE PROBE

The Radiacmeter Remote Monitoring Single Probe IM-5015/TD is designed to detect and monitor gamma radiation in roentgens per hour (r/hr). The monitoring device, or detector, is placed in a protected location and is connected by cable to the exposed detecting element.

The radiacmeter consists of a radiac detecting element, a radiac detecting element mounting bracket, a triaxial cable, a radiac indicator and a wooden carrying case.

The radiac indicator is a battery-operated instrument. It incorporates an electrometer box, a battery power source, a voltage check and operation switches, circuit balance controls and a 0 to 500 r/hr meter. A read line on the meter scale marked VOLT. MIN. denotes the lowest acceptable supply voltage reading. The electrometer box contains a constant current source which provides the zero reference and electrometer tube VI which amplifies the input circuit. Nine mercury cell batteries mounted on a plug-in board provide all the reference and control voltages for the radiacmeter.

The detecting element is a sealed ionization chamber which interconnects with the radiac indicator by means of a 50 or 100 ft. (15 or 30.5 m) triaxial cable.

The normal location of the indicator is an underground or basement center. The interconnecting cable passes through a conduit to the detecting element which is mounted 3 ft. (1 m) above the ground and as far away from buildings as the cable will allow. The indicator can be placed horizontally on a table or mounted vertically on a wall. Mounting details are supplied in the carrying case.

The front panel of the indicator houses the meter, the operation switch, the voltage check switch and 500 set controls. The two switches are mechanically interlocked so that one cannot be rotated unless the other is set to OFF.

*Indicator Radiac:* 10.5''h. x 7''w. x 5''d. (27 x 18 x 13 cm)

8 lb. 12 oz. (3969 gm)

*Detecting Element:* 6''h. x 3- $\frac{3}{8}$ '' dia. (15 x 9 cm)

1 lb. 14 oz. (851 gm)

*Cable Assembly:* 50' (15 m)

6 lb. 14 oz. (3118 gm)

*I-Conductor Twin Shield:* 100' long (30.5 m)

13 lb. (5797 gm)

*Carrying Case:* 23- $\frac{7}{8}$ ''l. 20''w. 8- $\frac{1}{8}$ ''d. (61x51x21 cm)

20 lb. complete (9072 gm)

### PHYSICAL AND ELECTRICAL DATA

*Range:* 0 — 500 R/hr

*Accuracy:*  $\pm 25\%$  within 3 minutes after switching on equipment

*Response Time:* 90% of maximum response within 15 seconds after exposure to radiation source.

*Energy Dependents:* 50 Kev to 2 Mev  $\pm 50\%$

*Battery Operating Life:* 1.3 voltage DC mercury cell type BA1391/U (250 hrs)

6.7 voltage DC mercury cell type TR165R (600 hrs)

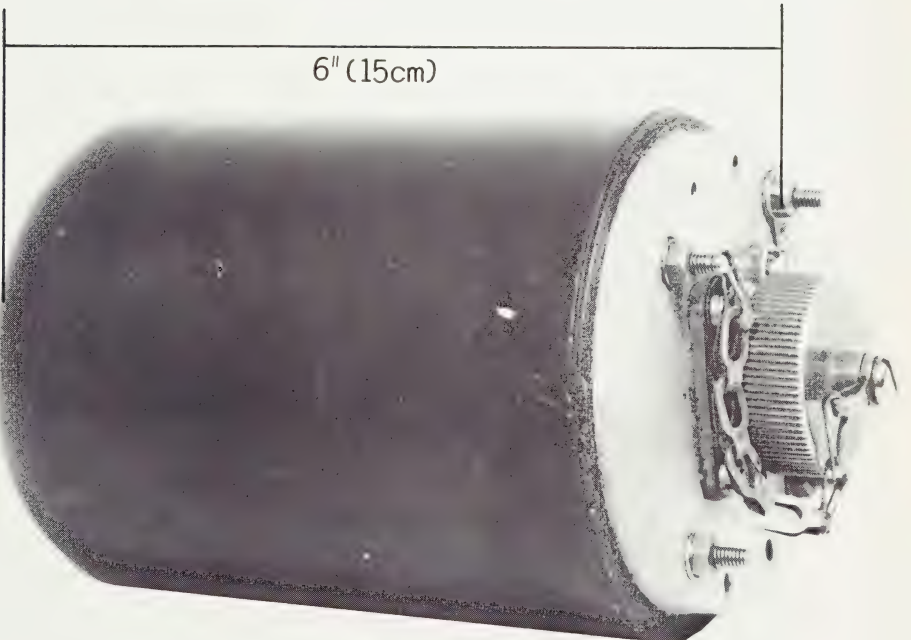
*Battery Service Life:* 2 years

Electrometer Tube Type ME1404 or equivalent.

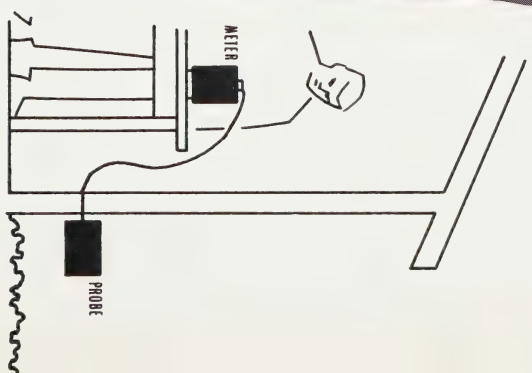




METER



PROBE



# RADIATION DETECTION SYSTEM AIRBORNE AN/ADR 501

The AN/ADR 501 is a radiation detection system which measures and records gamma radiation over the range 0.1 to 100 R/hr. It is intended for use in light aircraft or helicopters for the rapid reconnaissance of gamma radiation dose rates due to contamination on the ground. The equipment measures the radiation dose rate at the aircraft and may be converted to dose rate near the ground by multiplying the aerial dose rate by a factor which depends upon the height above ground. The radiation dose rate is recorded automatically.

The AN/ADR 501 consists of the following main components:

The Detector Radiac is the radiation sensitive portion of the AN/ADR 501. It converts gamma radiation dose rate to an electrical signal. The detector is a sealed unit which should be placed so that it is not shielded from the ground by large or bulky objects. It may be mounted inside the aircraft provided that only the aircraft skin is between it and the ground. It may also be mounted outside the aircraft.

The Cable Assembly connects the detector to the amplifier. It provides power to the detector and also carries the electrical signal from the detector to the amplifier.

The Amplifier Assembly amplifies the small electrical signal from the detector and provides sufficient power to operate the recorder assembly. It also includes an alarm device which gives a flashing light whenever the dose rate reaches a preset level. The operator can set the preset level anywhere between 0.1 and 10 R/hr. The amplifier assembly also includes the detector and bias batteries, which have very long life and should only need replacement during periodic maintenance. All operating controls are on the amplifier.

The Recorder Assembly consists of a recording milliammeter calibrated in Roentgens/hour. The meter may be used with the motor OFF, as an indicating meter only, or it may be run as a recorder. The record is provided as a series of dots on a pressure sensitive strip chart. A window on the front opens to permit writing on the strip chart, which may be done either with a pencil or a metal scribe.

The Battery Assembly consists of three separate power supplies, all using mercury cells for high performance:

- (a) *Detector Filament*
- (b) *Amplifier*
- (c) *Recorder*

The Amplifier, Recorder and Battery Assemblies mount in the main case and may be removed for repair or replacement. The detector and cable are used outside the case but provision is made to carry them in the case for convenience in transportation. Performance of the equipment is as follows:

- (a) *Range:* 0.1 to 100 R/hr. on one 3 decade quasi-logarithmic scale.
- (b) *Response Time:* 90% of correct reading within 3 seconds under adverse conditions, better under normal conditions.
- (c) *Chart Speed:* 60 in/hr or 6 in/hr (152.4 or 15.2 cm/hr), depending upon gear train used. Intermediate speeds may be obtained with special gear trains.
- (d) *Temperature Limits:* Detector, -40F (-40C) to 125F (52C)  
Recorder unit, -20F (-29C) to 125F (52C).
- (e) *Operating time:* Limited by batteries at low temperature extremes to 4 hrs. Much longer at normal temperatures. Chart time 12 hrs at max chart speed.
- (f) *Power Supplies:* Completely self-contained batteries.
- (g) *Radiation Sensitivity:* Gamma Radiation only, from 80 kev to over 3 mev. Essentially non-directional.
- (h) *Accuracy:*  $\pm 20\%$ .





## DETECTOR RADIAC TACTICAL DOSIMETER, DT60A/PD

The Detector, Radiac, Tactical Dosimeter DT60A/PD is a non self-indicating dosimeter which is worn about the neck as a pendant and is designed to record the total dose of gamma radiation from 0 to 600r to which it has been exposed. It is 1-½ ins. (3.8 cm) in diameter, ⅝ ins. (1.7 cm.) thick, and weighs 1 oz (28 gms). The sensitive element of the Dosimeter is radiophotoluminescent glass which emits luminescence under near ultra-violet irradiation after exposure to gamma radiation.

The Dosimeter is read by means of the Computer-Indicator Radiac Tactical Dosimeter Reader CP95A/PD which detects the intensity of the luminescence emitted and indicates it directly as a dose in roentgens.

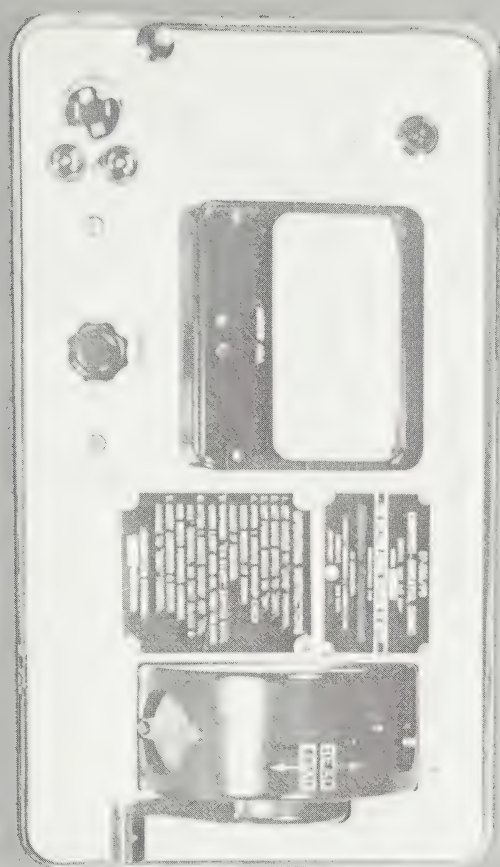
The Dosimeter meets the full range of characteristics of ruggedness and environmental performance for military equipment. It meets the applicable draft of operational characteristics given at Appendix 1 to the Annex to AC/196-WP/59 subject to the following comments:

- The range is 0 to 600r.;

- It does not record neutrons;

- It has not been tested against non-ionizing radiation, thermal radiation or blast.

This Dosimeter has been adopted for use by the Canadian Forces and has been produced in large quantities with satisfactory quality control according to the specification.



## RADIOACTIVITY SURVEY TRAINING SET

This equipment simulates the techniques of radioactive radiation measurement without the use of radioactive materials and, therefore, makes it possible to train personnel in these techniques without the dangers involved in exposing them to radioactivity.

While exposure to very small amounts of radioactivity may not be dangerous for short periods, exposure for longer periods, or exposure to larger amounts can be extremely dangerous. Personnel from Civil Defence, Military, Industrial and other organizations must be trained in the techniques of measurement of radioactivity and the use of radiation survey meters. It is obviously not practical to expose these personnel to large amounts of radiation during training, so a system must be used which simulates these measuring techniques and instruments, without the use of radioactive materials. The equipment described here meets this need, and has already been in quantity production by EMI-Cossor.

The principle used here is that instead of introducing radioactivity into the training area, this area is covered by a fixed frequency radio signal produced by a transmitter set up at the centre of the training area. Now, instead of using radioactivity detection meters, radio frequency field strength meters are used to detect the transmitted signal. These meters are constructed to look exactly like radioactive radiation survey meters, the meter scale being calibrated in Radiation Units (Roentgens) per hour. The trainee using this meter is operating and obtaining meter readings just as if he were measuring radioactivity. An extra control, not required on the field strength meter, is incorporated in order to duplicate the operation of the radioactivity meter.

Any number of these simulated survey meters can be used when training a group of personnel. They would carry a meter, and would operate in the area serviced by one central transmitter which represents a centre of radiation. To simulate an area with a more elaborate radioactive pattern, more than one transmitter can be used. Changing patterns of radioactivity can be simulated by varying the output level of one or more of the transmitters, and also by moving the transmitting antennas. The equipment will operate over an area of at least three square miles (7.77 km<sup>2</sup>).

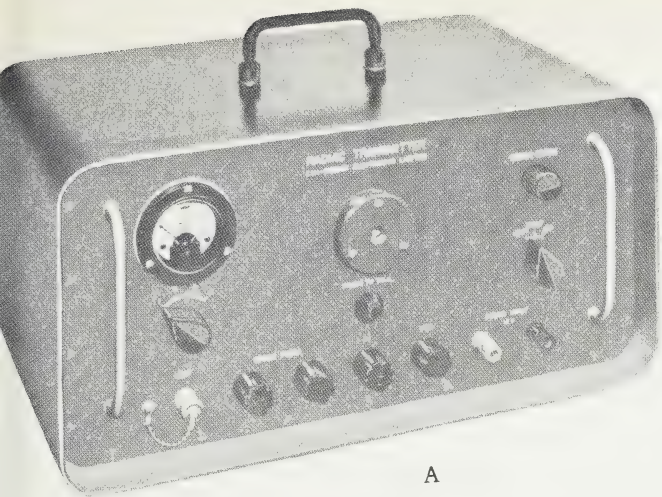
The transmitter and simulated survey meters are battery operated and portable. The survey meters will operate for 250 hours on one set of batteries which may be changed in the field under adverse conditions.

The whole equipment is extremely rugged. It was designed to meet stringent military specifications, and has been subjected to full shock and vibration tests. Each unit is completely sealed and is, therefore, completely waterproof and dust-proof. The equipment will operate over a wide range of ambient temperatures (−60 to +120°F) (−15.5°C to +44.4°C), and will stand dropping from four feet (1.2 m) and immersion in six feet (1.8 m) of water.

This equipment, as a minimum, consists of the following items:

- A. Transmitter complete with battery cable microphone, antenna feeder, etc. Battery for Transmitter (12v car type). (SM-5003/TDQ-501). Transmitter weighs 54 lbs (24.5 kg).
- B. Transmitting Antenna complete with tripod stand.
- C. Field Strength Meter. (Simulated Radiation Survey Meter). The number of meters used with each transmitter will depend on the number of personnel to be trained at any one time. (SM-5004/TDQ-501) and weighs 3.5 lbs (1.6 kg).
- D. Receiving Antenna. This fits on the operator's helmet—one is required for each meter.

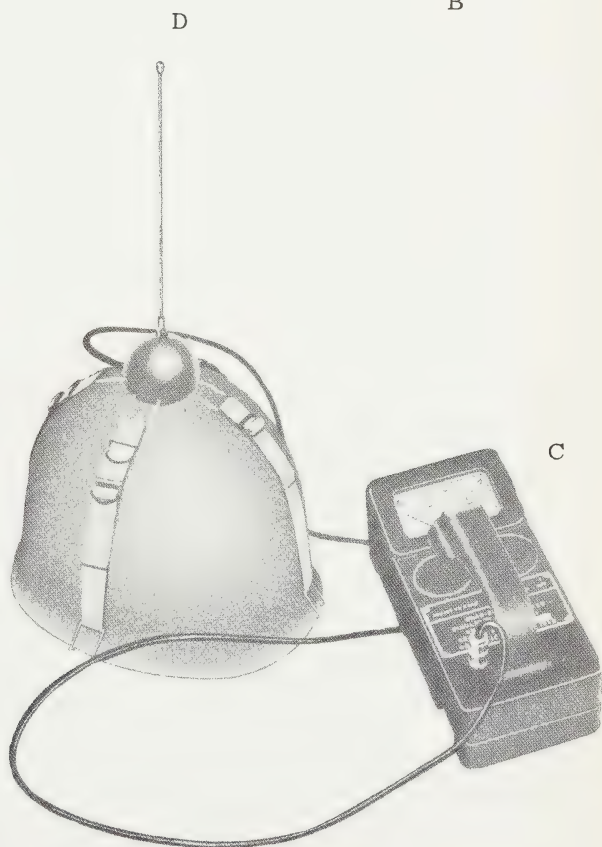




A



B



D

C

## IRRADIATION EQUIPMENT

The atom is a potent factor in the political economy of the world today—in the near future its impact will be even greater. It will play a greater role in all the aspects of economics, particularly in the newly developing nations.

To understand and become familiar with the handling and potential of this new form of energy needs the use of laboratory equipment which permits the safe investigation of both peaceful and defensive applications.

The sterilization, by Gamma Rays, of medical supplies is one of the uses of irradiation equipment. This equipment, designed and produced by Atomic Energy of Canada Limited, has been used to ensure that rations, being shipped to distant outposts, arrive there in such condition that long-term storage is possible. This again is the process of irradiation in a sterilizing role. Such applications have been established and are being refined and extended continually in many laboratories, and a significant contribution from Canada to these advances is the supply of sophisticated laboratory equipment suitable for such investigations.

A.E.C.L. Gammacells are in use in twenty countries for laboratory work. Illustrated is the GAMMACELL 220, a completely self-contained and portable irradiator requiring no additional shielding and with a capacity up to  $2.0 \times 10^6$  rads/hr is basically for research purposes.

The GAMMABEAM 150, one of a new series may be used in a laboratory role or for batch processing and is capable of delivering an output of 1500 roentgens per hour at one meter from the source in any of three beam configurations from full panoramic to pre-determined beam shape.

The unit is completely portable and is delivered with the source already loaded so that no transfer of active material is necessary in the field. A shielded room or controlled area is required for operation and the unit can be moved to different facilities as required without radiation hazards to personnel concerned.

GAMMABEAMS, for batch or large scale experimental irradiations, are now entering service, and can be installed rapidly, in prepared concrete irradiation rooms, for the preservation and extended storage of local produce.

Large scale permanent Industrial Installations are being built now, but to realize the immense potential of irradiation, much additional laboratory work, for which GAMMACELLS and GAMMABEAMS are needed, still must be completed.

Since Cobalt 60 became available in ever-increasing quantities, scientists have used its high energy gamma emission to study radiation effects on materials of all kinds. Investigations are being carried out on such diversified products as foods, textiles, rubber, glass and chemicals. The range of radiation studies is limited only by the imagination of scientists and researchers the world over.





## BLOOD TESTING KIT CHOLINESTERASE

One of the undesirable characteristics of the antidotes to nerve gasses is that they tend to mask the true condition of the victim. The requirement to cut through this condition has been met by the Canadian Army in the development and production of a kit which determines the cholinesterase enzyme level of the blood within a range of 0 to 100%.

The kit has been developed with three main design criteria; use by non-technical personnel, no dependence on laboratory or other cumbersome equipment and the speed and accuracy with which results may be obtained. The inherent factors of low cost and hence ready availability of issue to all troop levels should not be overlooked.

The packaged kit weighs 2 lbs. (.9 kilo) and measures  $4 \times 5 \times 7$  in. ( $10.2 \times 12.7 \times 17.8$  cm).

The kit consists of two aprons, one for collection and one for analysis. Each apron contains sufficient components for collection and analysis of 49 samples of blood. The components for the collection of blood are contained in peckets of the collection apron and those for the analysis of blood are contained in pockets of the analysis apron. The two aprons with their contents and instruction book are packed in a waterproof container.

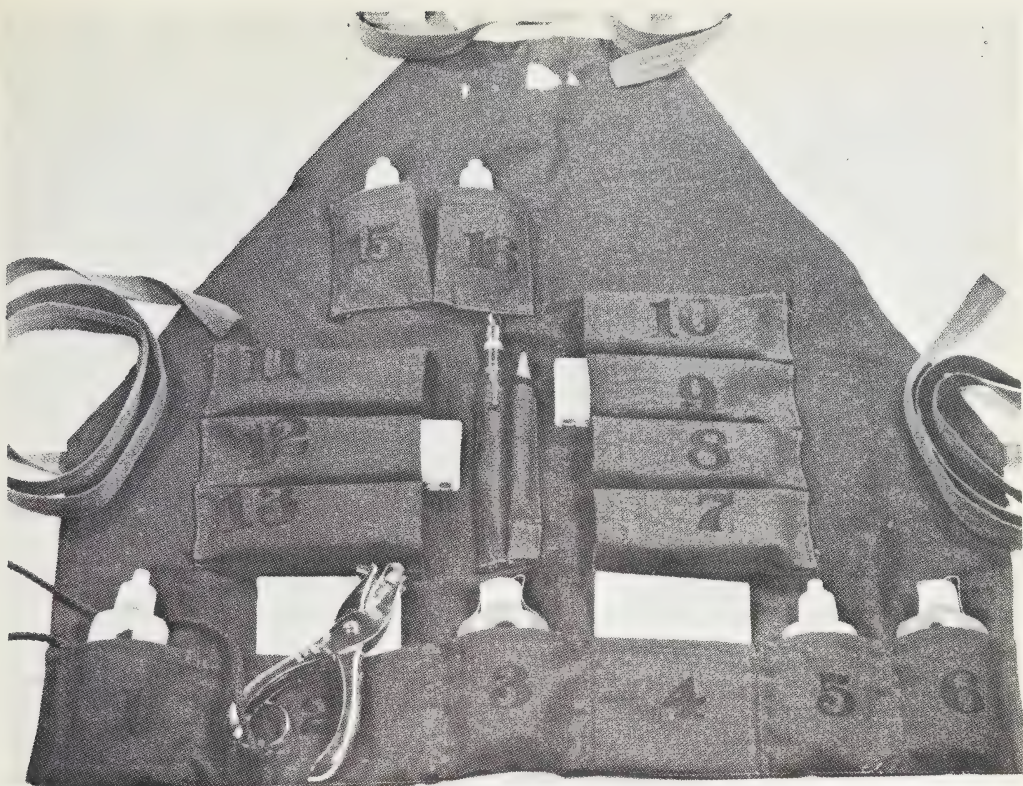
The main uses of the equipment are defined as follows:

- (a) To assess the tolerance of survivors of a nerve gas attack to further exposure.
- (b) To assist in the diagnosis of casualties or disabilities which indicate exposure to cumulative small doses of nerve gasses such as may be experienced through covert attacks.
- (c) To assess the degree of poisoning of non-severe casualties so as to assist in the determination of therapy.

Employment of the kit is quite simple and follows these general outlines:

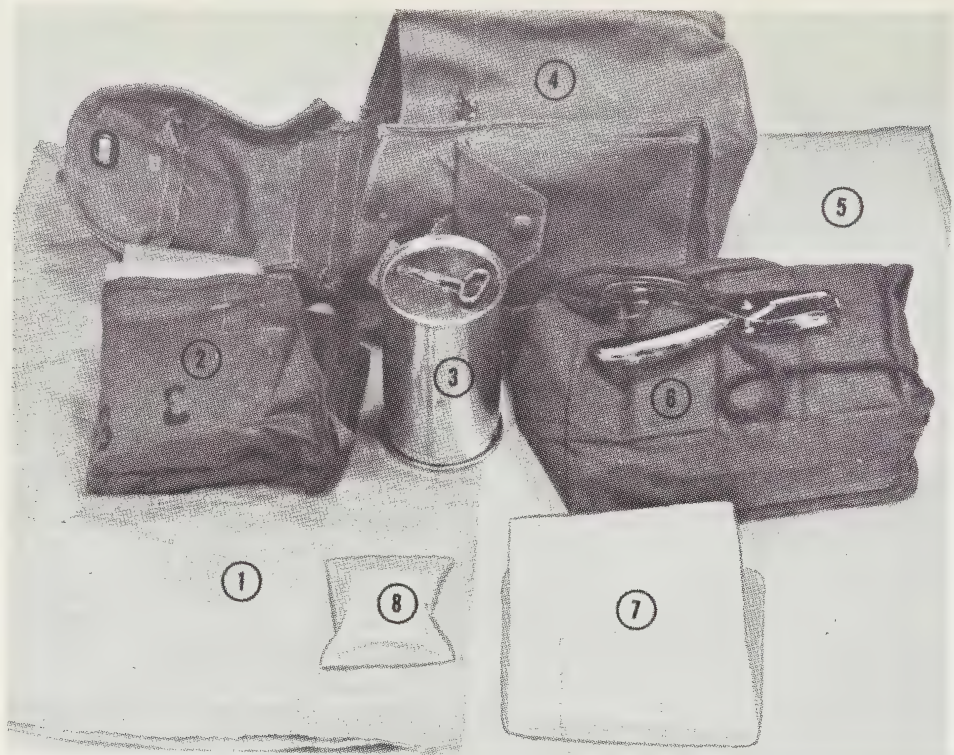
Blood is collected by finger prick and collection paper. When dried, a disk of blood-impregnated paper (aliquot) is punched into a miniature test tube; two sets of reagents are added in sequence and the resultant colour produced, in specified times and when matched against the provided colour chart, indicates the percentage of blood cholinesterase of the suspected casualty.

In accelerated storage trials the kit has proven stable and under normal conditions, five years storage life may be expected.



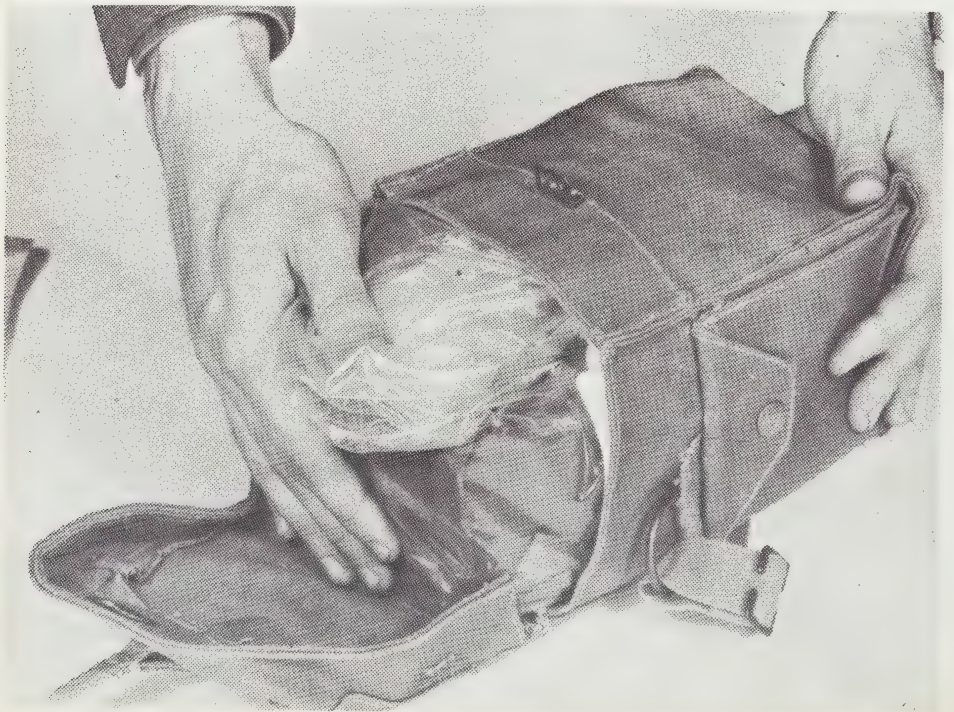


# BLOOD KIT CHOLINESTERASE



- 1 Outer Paper Wrapper
- 2 Blood Sampling Apron
- 3 Container for Saline and Antiseptic
- 4 Haversack

- 5 Polyethylene Inner Wrapper
- 6 Blood Testing Apron
- 7 Instruction Manual
- 8 Desiccant





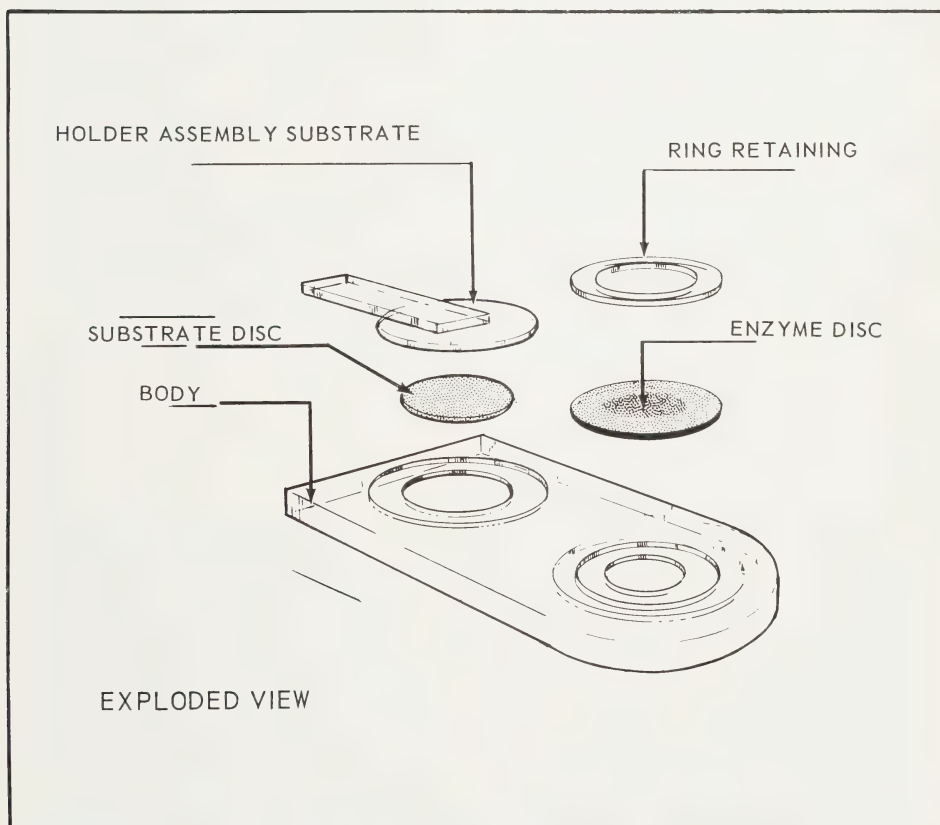
## DETECTOR CHEMICAL AGENT (Nerve Vapour)

The Canadian Army has developed and adopted a simple nerve vapour detector which may be used by all personnel and whose cost is low enough to allow individual issue.

While other equipments exist which will perform this test, they are considered too bulky and complicated to be issued on a personal scale.

The detector consists of two main parts comprising a body, containing a bovine acetylcholinesterase-impregnated test paper and a holder containing an indoxyl acetate-impregnated test paper. When the test paper in the body is moistened, exposed to the atmosphere and then pressed into contact with the test paper in the holder, the cholinesterase test paper will turn blue or green in the absence of nerve agent vapour. If nerve agent vapour is present, the colour of the test paper will remain unchanged after contact. The detector, together with an instruction sheet, is packaged in an airtight moisture-proof foil wrap for protection against environmental conditions until required for use.

The item is quite small being only  $3\frac{1}{2} \times 1\frac{1}{8} \times \frac{1}{4}$  in. ( $8.9 \times 2.9 \times .65$  cm) and is packaged in a thin lead foil tube. These individual units are then packaged in groups of ten in an air tight, moisture proof container which provides protection until required for use and is  $3\frac{3}{4} \times 3\frac{3}{4} \times 2$  in. ( $9.5 \times 9.5 \times 5.1$  cm).



## CASE, WATER TESTING, POISONS

The Case, Water Testing, Poisons is a kit consisting of a number of vials of chemical reagents and associated items packed in a metal case. It is designed to enable water to be qualitatively tested for the presence of arsenic, cyanide, heavy metals (lead, mercury, copper), mustard agents, and nerve agents. The pH of water can also be determined.

The kit is for issue to Unit Medical Officers and all Medical Field Units for use in indicating the presence of unacceptable concentrations of CW agents and chemical contaminants in field water supply sources proposed for short period use. If a positive reading is obtained with the kit, the water tested must be banned from use.

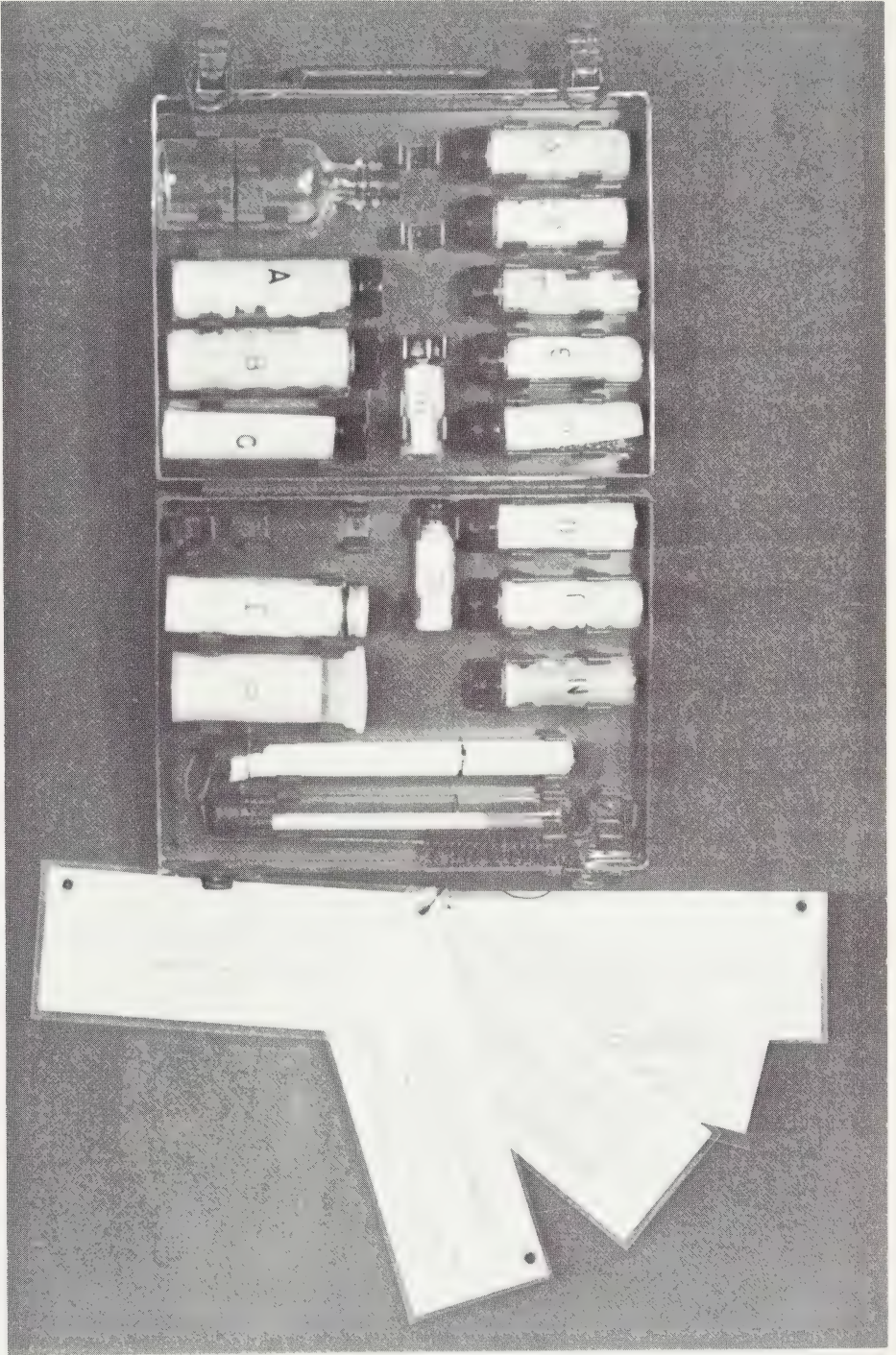
Minimum detectable concentrations are as follows:

• Arsenic/Antimony	0.5	ppm
• Cyanogen Chloride	10	ppm
• Cyanide (as CN)	10	ppm
• Heavy metals — copper	2	ppm
lead	8	ppm
mercury	8	ppm
• Mustards — HN	2	ppm
HD	50	ppm
• GA	0.09	ppm
• GB	0.03	ppm
• VX	0.03	ppm

Each kit contains individual instructions on separate sheets enclosed in plastic.

The components of the kit are packaged in a metal case, the lid of which is held in place by spring clips. The size of the case is 8-1/2 in x 6-5/8 in x 3 in (21.6 cm x 16.8 cm x 7.6 cm) and the weight of the complete kit is 4 lbs (1.8 kg).

The set has been adopted for use by the Canadian Forces and production to meet Canadian needs has been carried out by the Defence Chemical Biological and Radiological Laboratories.





## SUPPORT KIT, OVERHEAD PROTECTION, C1. (SKOP)

In the construction of a conventional two man hair-pin shelter some 177 pounds (80.4 kg) of stores are required. From this figure it may be seen that an extremely large addition would be made to the logistic tail if this much needed protection were to be carried. The conventional shelter is not an acceptable answer to the problem.

After four years of development and field trials, which included weathering, blast and shock the Canadian Army has produced a kit which will provide forward troops with overhead protection, yet weighs only 1.12% of the conventional equipment.

The Support Kit, Overhead Protection (SKOP) weighs less than 2 pounds (.85 Kg), has a volume of 64 cubic inches (104.87 cc) and can be erected, supporting 18 inches (45.72 cm) of compacted earth, in less than 10 minutes.

The Kit, now accepted as Standard A in the Canadian Army, consists of:—

- (a) A camouflaged coated polyester film.

This is a membrane which is 8 feet long by 5 feet wide. (2.43 m.  $\times$  1.52 m.) and is 3mm. in thickness.

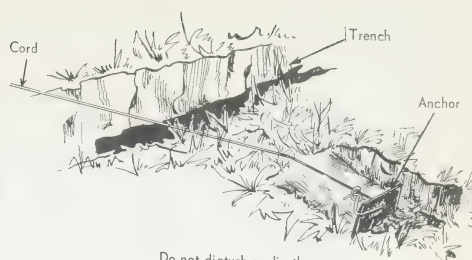
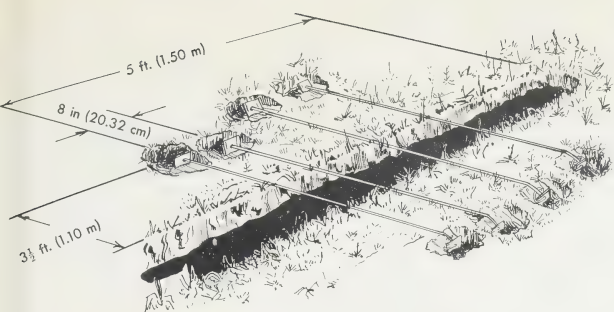
- (b) Eight aluminum anchors.

The 6 inch  $\times$  4 inch (15.2 cm  $\times$  10.1 cm) anchors are chemically treated to improve camouflage characteristics.

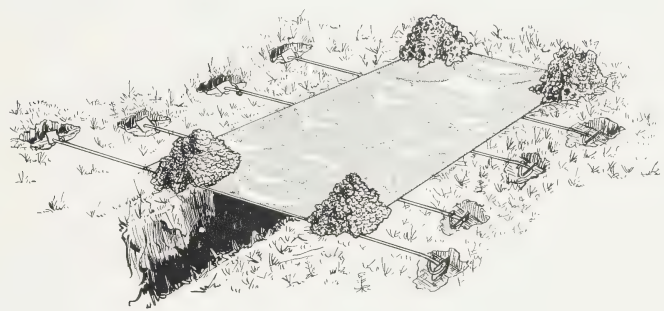
- (c) Four terylene cordage assemblies.

The cordage assemblies have a toggle at each end for rapid connection to the anchors. So that the 13 foot long (3.96m) cordages may be tensioned and adjusted to avoid obstacles in the ground, they are provided with a guy line hitch.

To construct the overhead protection over a battle-trench, four pairs of anchors, each pair connected by a cordage assembly, are driven in the ground. Anchors should be placed at least 3½ feet (1.06m.) from the shelter wall. The first pair is placed at the shelter entrance and at 90 degrees to the longitudinal axis of the shelter, the second set approximately 8 inches (20.32 cm) away, and the third and fourth pairs dividing the remainder of the 5 foot (1.52m.) long shelter into 3 equal parts. When the anchors are placed the cordages are tensioned with a pull of about 35 pounds (15.87 Kg.). The polyester film (membrane) is locked in place around the first two cordage assemblies and positioned over the proposed shelter, with an equal lap on each side and at least 18 inches (45.72 cm) at the back. Earth is built up around the three outer edges of the membrane in the form of a horseshoe, and compacted to help secure the film. The centre portion is then filled with earth, working gradually towards the longitudinal centre-line of the shelter. When 18 inches (45.72 cm.) of compacted overhead protection has been attained it may be camouflaged.

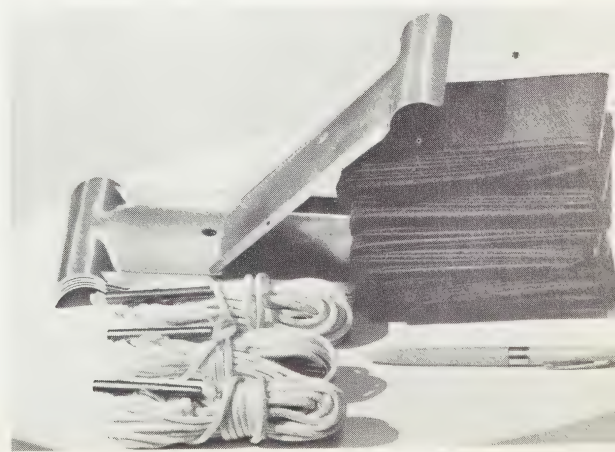
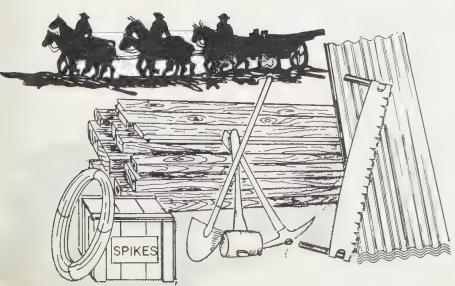
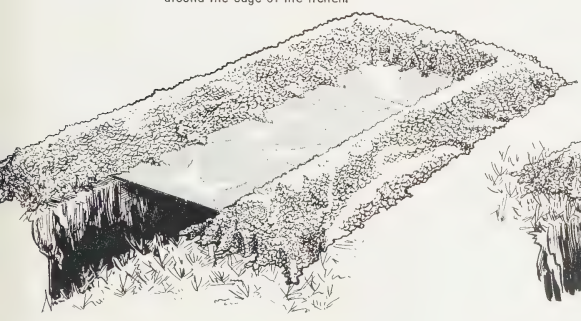


Do not disturb or dig the soil in front of the anchors.



Build and compact a ridge of soil one foot in depth around the edge of the trench.

Gently fill in towards the centre from the ridge and compact to a minimum depth of 12 inches. Camouflage if required.



## NAVIGATION SET, LAND VEHICULAR C2

Development and production of this equipment was undertaken by the Canadian Army and Aviation Electric Limited to meet conditions of modern warfare where units are required to move rapidly about the battlefield under cover of complete darkness or in fog or smoke, or when all hatch covers must be kept closed. Vehicles so equipped are also enabled to navigate accurately on terrain devoid of recognizable landmarks, where reliable maps are not available or in areas devoid of permanent topographical features such as desert or arctic regions.

The continuous display of the present position of the vehicle is obtained by automatic-dead-reckoning. The distance travelled by the vehicle is measured by the odometer drive and the direction of travel is derived electrically from a compass. A Computer automatically works out the East/West and the North/South components of the vehicle movement and transmits this information in the form of direct current impulses to the Heading & Position Indicator and Vehicle Position Plotter. The heading signal from the compass is also retransmitted to these display units. The flexible mechanical drive shaft by which the distance is fed into the Computer can, if desirable, be replaced by an electrical distance transmission system composed of a distance transmitter and a distance receiver.

The Heading & Position Indicator unit displays two "4-digit" map references — one for Eastings and one for Northings. These are set to the map reference of the vehicle location before moving off and, in operation, continually record the position of the vehicle in terms of map co-ordinates.

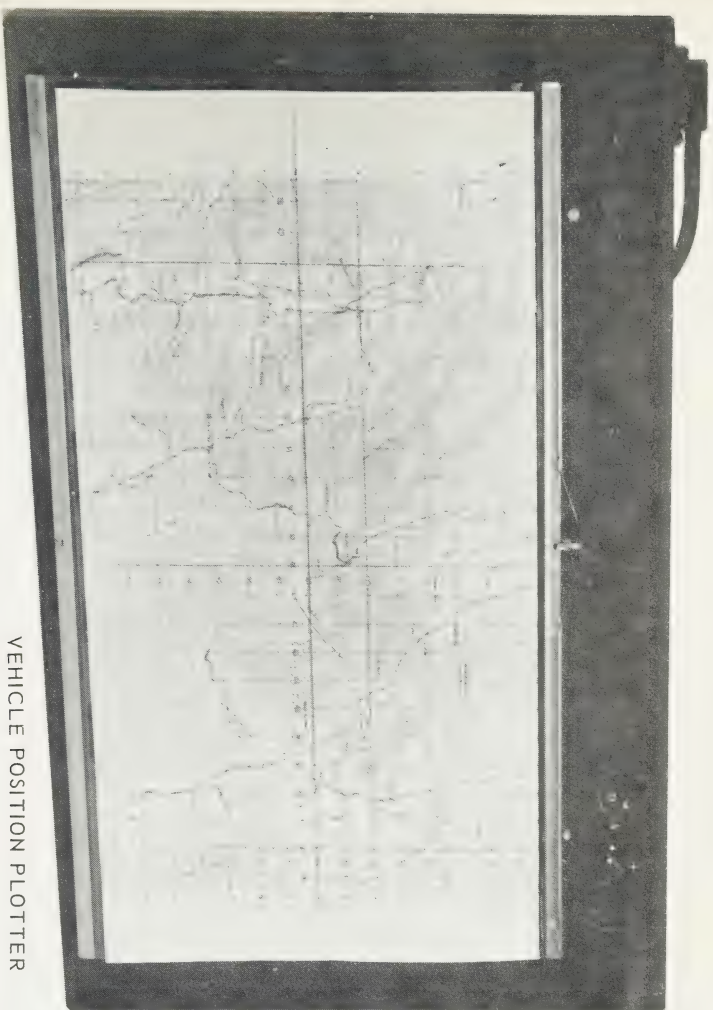
A map selector switch provides for scales of 1:25,000, 1:50,000, 1:100,000 and 1:250,000. The Heading Indicator is provided for use where the driver is physically separated from the vehicle commander.

The Vehicle Position Plotter provides a continuous pictorial presentation of the exact geographical location of the vehicle and the direction in which it is headed. This enables the navigator to steer the vehicle along any prescribed course without manual plotting or mental calculations. This is achieved by setting into a transparent holder on the Plotter the pertinent section of a standard military map. An illuminated image comprising a positional 'dot' and directional 'arrow' is projected on to the underside of the map. At the commencement of a run the image is set to the map co-ordinate position of the vehicle corresponding to the map references on the Heading & Position Indicator after which the vehicle location and heading will be both digitally and pictorially displayed to within one percent of distance travelled.

User evaluation trials have been successfully carried out in several NATO countries including the United States. Towards the end of 1965, a contract was awarded Aviation Electric by the United Kingdom, providing for delivery of 235 sets including field support check-out equipment. Sets have been in operation with the Canadian Army for some time. A requirement has also become evident for the equipment for use at Airports for the guidance of aircraft and service vehicles to and from terminal areas under conditions of unfavourable visibility. London Airport, noteworthy for its extreme fog conditions, acquired a Navigation Set in 1965.

Although this equipment was designed and developed for use on tracked or wheeled vehicles to facilitate troop movement, its use has indicated future potential for the basic equipment in applications connected with tactical display, destination or target computation and fire control techniques. In this regard, a Range and Bearing Computer has been developed as an auxiliary unit for computing the range and bearing of a target in relation to the vehicle in which the complete set is mounted.

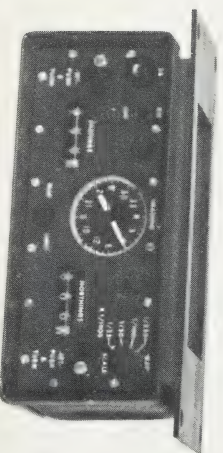




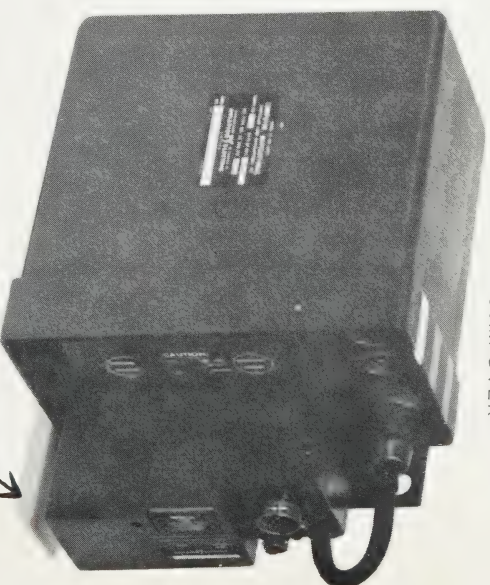
VEHICLE POSITION PLOTTER



HEADING INDICATOR



HEADING AND POSITION INDICATOR



COMPUTER

ELECTRICAL DISTANCE  
RECEIVER



ELECTRICAL DISTANCE  
TRANSMITTER

## LAND NAVIGATION SYSTEM TYPE LNS-102

Aviation Electric Limited, Montreal, Canada, has completed the research and development on a new type of navigation system which utilizes a Magnetic Heading Reference instead of the Gyro Compass used in earlier versions. This new system, designated LNS-102, has been developed to meet the need for a low-cost system which can be installed in non-armoured vehicles and is offered as an alternative to the Land Navigation Set Type C2 which has been standardized for use by the Canadian and British Armies.

The LNS-102 system is similar to the LNS-C2, except that the heading input is obtained from a magnetic sensor instead of from a Gyro Compass. It is completely self-contained, operates from the vehicle battery, and provides an average navigation accuracy to within 1.5% of distance travelled.

When a Magnetic Heading Reference is employed, it is necessary to compensate for the permanent and induced magnetism of the steel and iron parts of the vehicle. In addition, this compensation, to be most effective should be continuous and in the system, modifications are incorporated into the standard Computer which satisfy this requirement.

The LNS-102 system described consists of four separate units.

Magnetic Detector and Mast Assembly  
Computer  
Indicator, Heading and Position (IHP)  
Static Inverter

As in the gyrocompass system, Land Navigation Set Type C2, a Vehicle Position Plotter (VPP) is available, together with an alternative version which features the use of a combined Computer-Indicator. The basic system requires approximately 19 VA, 400 Hz of electrical power, or 40 VA when the VPP is used. After initial installation of the system, the compensation for the permanent and induced magnetic components of the vehicle can be accomplished in about two hours by means of a standard set-up procedure.

**The Magnetic Detector and Mast Assembly AE 300800** consists of a detector in a protective case, a mast up to one meter (39.4") high and a mounting pedestal.

**The Computer AE 300118** is a modified version of the Computer used in the C2 system and contains two additional potentiometers and two electro-mechanical resolvers with their associated gear trains.

**The Heading and Position Indicator AE300126** is identical to that used in the LNS-101 system, except that the unit lighting on-off switch is modified to a system on-off switch. A data sheet describing the unit is attached.

**The Static Inverter AE 300810** has been designed to operate under the usual military environments.

The Company is also developing a line of low cost medium accuracy land navigation equipment involving the latest techniques in electronics and electro-optics. These new units are in an advanced stage of development, the first being a Solid State Computer Indicator which will be a high reliability miniaturized computer and display unit adaptable for use with both gyro compass and magnetic heading reference unit. The other unit is the Automatic Position Reporting system which will permit the automatic interrogation of a vehicle with the land navigation system via a standard communications link whereby the coordinate position of the vehicle can be automatically and continuously displayed at a command position.

The development work in hand at Aviation Electric is ensuring that the international users will continue to have modern and reliable equipments made available to them.





## GYROSCOPIC COMPASSES

Over 425 of the Sperry MK 23 Gyro Compasses have been produced to date for U.S., Canadian and NATO navies which would indicate the general acceptance of claims for accuracy, ruggedness and reliability.

This compass, a small compact unit capable of withstanding severe operating conditions encountered in small craft, submarines and large ships, continuously provides accurate heading data. The present system is being manufactured in accordance with Specification MIL-C-15952F (SHIPS) and consists of the following:

- Master Unit
- Transistorized Control Unit
- Alarm Control Unit
- Speed Unit
- Static Power Supply & Control Unit.

The deck mounted Master Unit consists of a shock-mounted, oil filled Binnacle and the compass element which is gimballed to provide freedom of  $\pm 45$  deg. about the roll and pitch axis. The Control Cabinet consists of a drip-proof, bulk-head-mounted enclosure which houses the Control Panel, D.C. power supply, Amplifiers and various phasing networks.

Speed correction is applied by means of a precision potentiometer which produces a voltage proportional to speed set in manually or driven from an electro magnetic log. The alarm system provides a warning should the system fail.

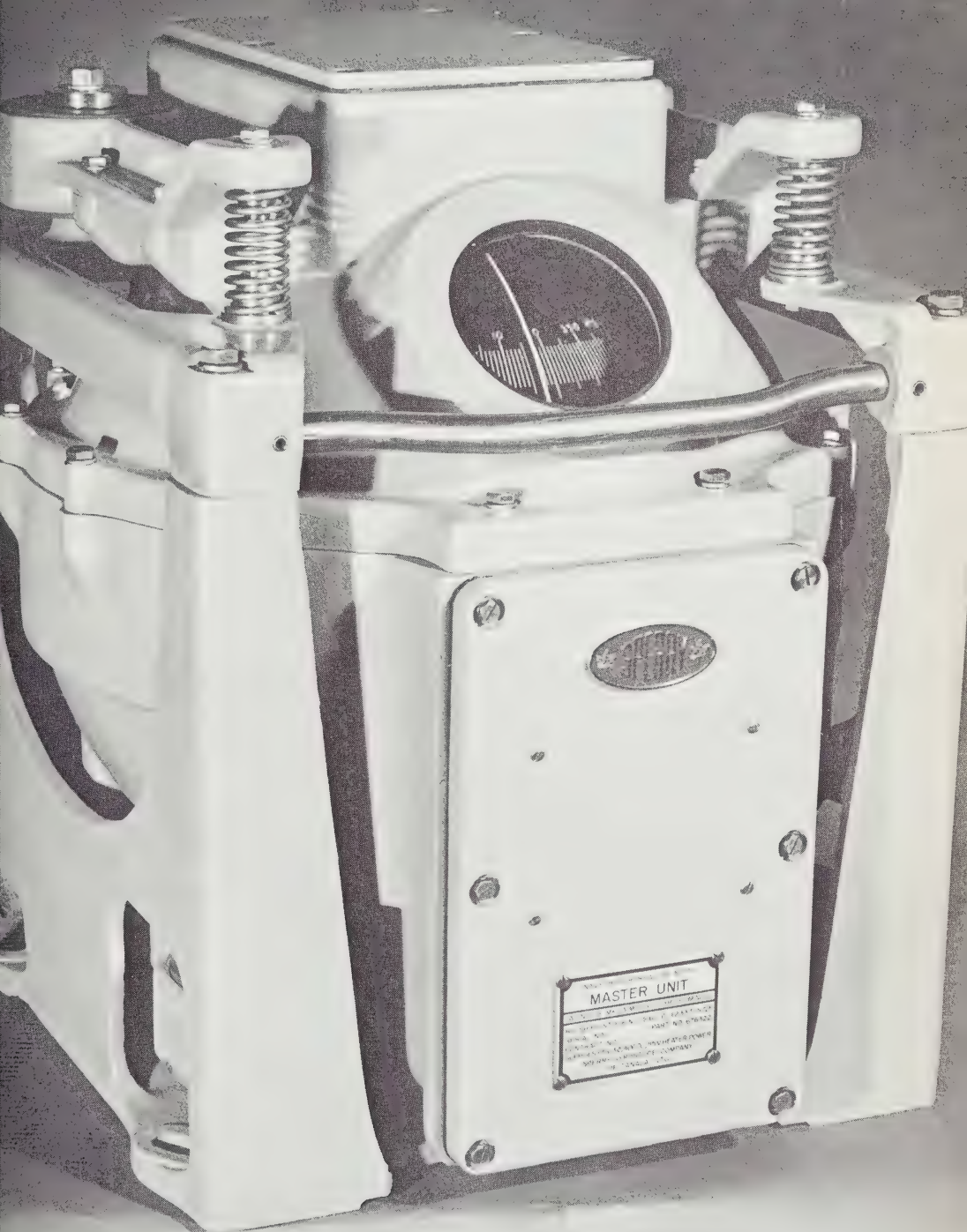
This compass, in addition to being a north seeking Gyro, may be used as a directional Gyro with a free drift rate of  $\pm 1/4^\circ$  per hour. Heading data is normally supplied as 1 and 36 speed synchro transmission. Accuracy of the system is  $0.75^\circ$ .

From this development two other compass systems, to meet varied requirements, have been evolved which still maintain the basic design of the MK 23.

Vehicle navigation systems have become essential in modern warfare. Under conditions of darkness, fog, smoke or where the terrain is devoid of distinctive landmarks, vehicle navigation can be most difficult and accuracy may only be obtained through the use of ill afforded time. The Sperry Vehicle Gyro Compass has been designed around this requirement and is compatible with both "readout" and plotting board systems of vehicle navigation.

A further development of the basic Sperry compass has been to provide a direct reading compass system for PT Boats. In this system, due to the small size and compact design, the master unit is mounted directly on the bridge and thus eliminates the requirement for repeaters. This feature also automatically reduces the circuitry carried and at the same time eases maintenance problems and increases system reliability.

*(An application for this compass may be seen on page I-208)*



## MECHANICAL BALL RESOLVERS

Aviation Electric Ball Resolvers are precision, analogue, mechanical devices capable of continuously resolving polar coordinate inputs into rectangular coordinate outputs. The resolvers will, from suitable inputs, generate any of the six basic trigonometric functions, but they are particularly suited to the role of sine-cosine function generators. Aviation Electric Ball Resolvers are widely used in rho theta navigation systems as sine-cosine and secant-tangent function generators.

The AEL Ball Resolver is a lightweight, rugged, and relatively low-cost solution to many two- and three-dimensional analogue vector component problems, and has potential applications in automatic plotting boards, flight simulators, target range and bearing computer, and air ground marine and submarine navigation systems.

### **Type AE300007 Ball Resolver (1" Ball)**

<i>Accuracy:</i>	0.5 of one percent.
<i>Weight:</i>	6 ozs. maximum.
<i>Pre-Lubricated:</i>	Lubrication required only at overhaul.
<i>Designed to meet the following conditions:</i>	
<i>High Temp:</i>	MIL-E-5272, Proc. 11 + 71°C for 48 hours.
<i>Low Temp:</i>	MIL-E-5272, Proc. 11 - 62°C for 72 hours non-operating, - 54°C for 24 hours and tested, at end of time, at - 54°C.
<i>Altitude &amp; Temp:</i>	Altitude 70,000 ft. at - 54°C non-operating. Tested at sea level at - 50°C.
<i>Humidity:</i>	MIL-E-5272, Proc. III. 95% for 360 hours.
<i>Vibration:</i>	MIL-E-5272, Proc. XIII. 5 to 500 c.p.s.
<i>Shock:</i>	MIL-E-5400 Para. 3.2.21.6.1. 15g, three axes.

#### **RECOMMENDED OPERATING PARAMETERS**

<i>Operating Speeds:</i>	0-20 r.p.m. on linear input gear with short periods at speeds not in excess of 125 r.p.m. (e.g. 1 minute bursts for memory circuits).
<i>Output Shaft Loads:</i>	0.1 to 0.2 oz. inches.
<i>Input Torques:</i>	Linear — Average under 3.0 oz. inches. Max. starting 10 oz. inches.
<i>(Room Temp.)</i>	Angle — Average under 3.0 oz. inches. Max. starting 10 oz. inches.
<b>GENERAL DATA</b>	
<i>Input Ratio:</i>	Linear gear to driving roller 1:2
<i>Input Ratio:</i>	Angle gear to Yoke 1:1
<i>Outputs:</i>	2 x cosine angle linear input and 2 x sine angle linear input.
<i>Life:</i>	When operated within recommended parameters, 3,000,000 revolutions of the driving roller (i.e. 2500 hours at 10 r.p.m. on linear input shaft).

### **Type AE300040 Miniature Ball Resolver (5/8" Ball)**

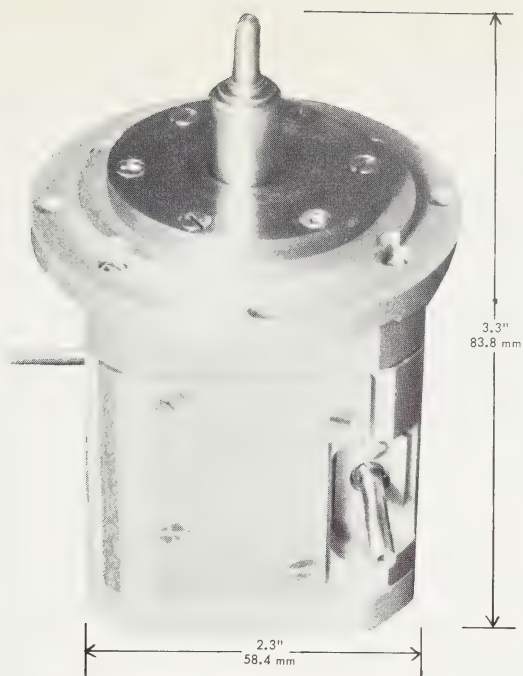
<i>Accuracy:</i>	0.1 of one percent.
<i>Weight:</i>	14.5 ozs. (approx.)
<i>Pre-Lubricated:</i>	Lubrication required only at overhaul.
<i>High Temp:</i>	To + 125°C.
<i>Low Temp:</i>	To - 54°C, MIL-E-5400E (ASG), Class 2 Equipment.
<i>Altitude:</i>	Sea level to 70,000 ft. MIL-E-5400E (ASG), Class 2 Equipment.
<i>Humidity:</i>	95% RH as per MIL-T-5422E (ASG), para. 4.4
<i>Attitude:</i>	All positions.
<i>Vibration:</i>	5-62 cps at 0.01 in. double amplitude and 62-500 cps at $\pm 2G$ ; MIL-E-5400E (ASG) para. 3.2.21.5.2.
<i>Shock:</i>	18 impact shocks of 15G as per MIL-E-5400E (ASG), para. 3.2.21.6.1.
<i>Linear</i>	
<i>Input Speed:</i>	40 rpm (max.) on the linear input shaft.
<i>Input</i>	
<i>Running Torque:</i>	(Linear and Angle Input shafts - With zero output shaft loads) is less than 5 oz. in. at - 54°C and less than 3 oz. in. at + 20° and + 125°C.
<i>Starting Torque:</i>	(Linear and Angle input shafts) is less than 10 oz. in. at - 54°C with no output shaft loads.
<i>Life:</i>	$1.5 \times 10^6$ linear input shaft revolutions under normal operating conditions.

#### **RECOMMENDED OPERATING PARAMETERS**

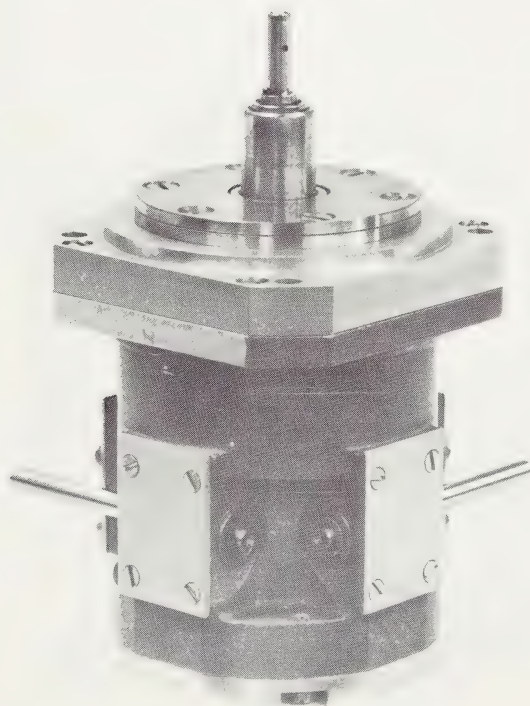
<i>Speed:</i>	18 rpm linear input (number of revolutions not to exceed 600 on any fixed heading).
<i>Output Shaft Loads:</i>	0.1 oz. in. (max.).
<i>Input Ratio:</i>	Input shaft to driving roller, 1:2      Angle shaft to yoke 1:1

Several versions of the AEL Ball Resolver exist and a number of types are approved for use in Canadian, United States, and NATO military applications. Engineering services are available to review feasibility of proposed applications and to ensure that the most suitable unit is matched to specific equipment and environmental conditions.





Type AE 300007 Mechanical Ball Resolver



Type AE 300040 Mechanical Ball Resolver

## FLUIDIC ELEMENTS

These devices, applicable to complex control systems in fields as diverse as industrial process operations and missile guidance systems, are equally effective with gas or liquid as an operating medium and having no moving parts are thus resistant to the severest environmental conditions as well as to shock, vibration or line pressure fluctuations. Aviation Electric Limited has developed and is marketing a line of fluidic logic elements and amplifiers, which through use of a unique vortex venting technique (patent pending), completely eliminates the impedance matching problems normally associated with the inter-connection of fluidic devices. Mono-stable and bi-stable logic elements operating in the 1-15 psig input pressure range are currently available. The mono-stable element has a dual input and can therefore also be used as an OR gate. Both elements can withstand variations in output leg loading from fully open to completely blocked without false switching or change in operating characteristics and can even tolerate reverse flows in the inactive leg without "loss of memory". Pressure recovery ratio in the fully blocked conditions is in excess of 40% and the flow recovery ratio in the completely open condition is in excess of 110% being greater than 100% because of the fluid entrainment associated with the vortex venting action. Switching time is of the order of .0004 seconds and switching pressure is less than 15% of the power jet pressure.

A fluidic diode has also been developed and is also currently available. This device, which also makes use of the vortex venting technique, has a reverse flow ratio of less than 4% and, among other applications, could be used as an insert in the connecting lines of existing fluidic systems to overcome particularly troublesome load matching problems.

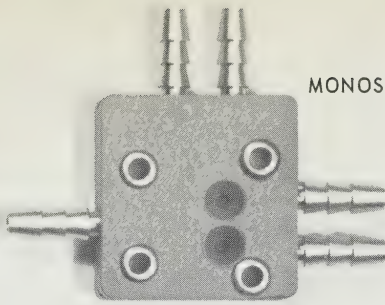
Also under development is a proportional amplifying element, operating in the 1-15 psig range which features an extremely favourable signal to noise ratio (and hence superior dynamic range), as well as the same immunity to load variations that are provided by the mono-stable and bi-stable elements. These novel vented elements have been subjected to an exhaustive series of tests. Several control systems, mainly for local industrial applications, have been designed and bread-boarded using the bi-stable and mono-stable elements and these control systems, in addition to meeting the performance requirements imposed, represent a significant reduction in cost and an improvement in reliability compared with the conventional electronic or pneumatic control equipments they will replace.

A general purpose Fluidic Sequence Controller is an example of the industrially oriented applications that are being investigated. This controller is designed to actuate a number of separate pneumatic cylinders in a timed sequence. An air pulse is supplied when the operator starts the operation, while a pulse, supplied by a fluidic switch when the operation is complete, initiates the sequencing which actuates different cylinders on the order of 0, 2, 3 and 5 seconds intervals or equivalent.

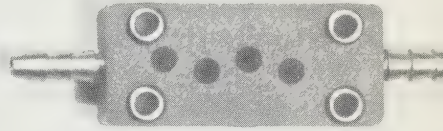
At the end of the sequence the machine is completely reset and ready to receive another start signal. Adjustable restrictors and fixed volumes are used to achieve the specified time delays. The logic decisions are performed by AEL fluidic elements using air at 3-5 psi and the final logic output is used to operate ball type switching valves which control air at up to 100 psi line pressure to actuate the high pressure pneumatic cylinders. The cost of this controller is about two-thirds the cost of conventional equipment.

Complete operating characteristics and data are obtainable for all devices as well as engineering services to study application feasibility.

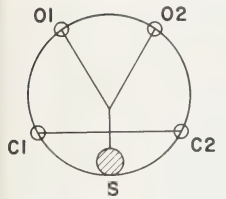
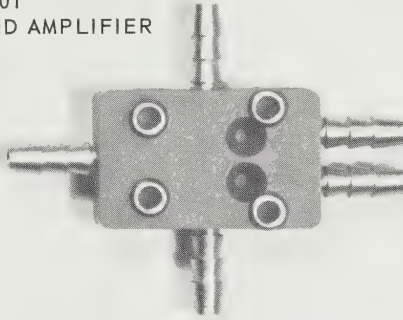
A TYPE 1100 M 01  
MONOSTABLE FLUID AMPLIFIER



B TYPE 1200 D 01  
FLUID STATE DIODE



C TYPE 1000 B 01  
BISTABLE FLUID AMPLIFIER



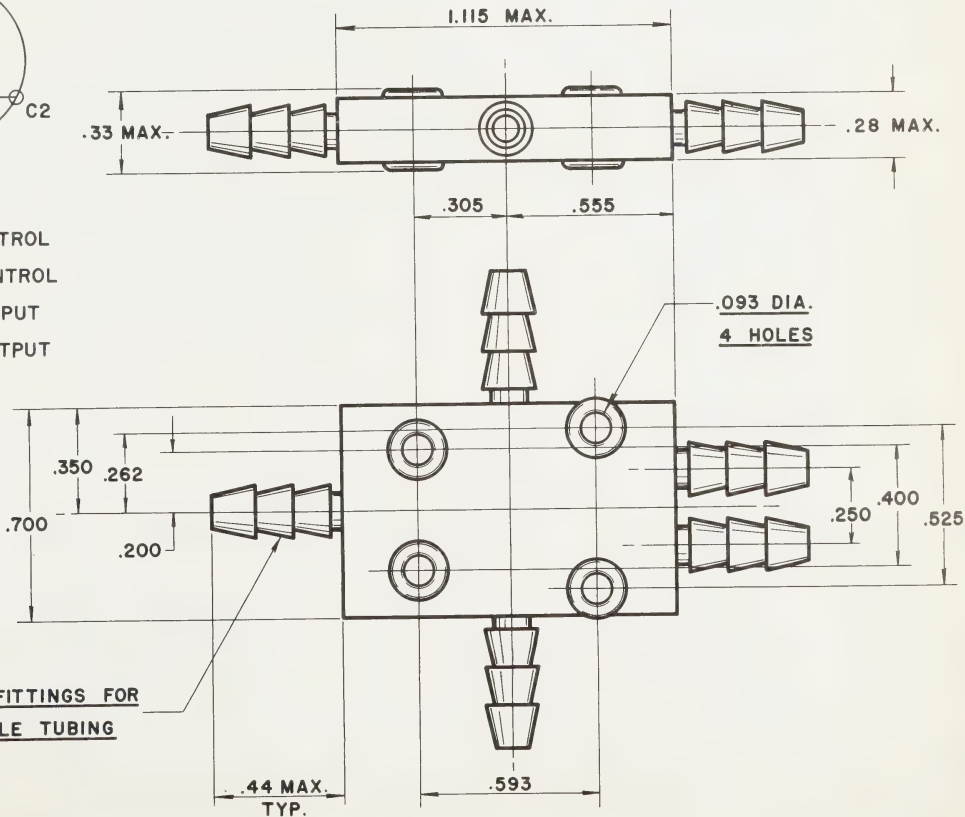
S = SUPPLY

C1 = LEFT CONTROL

C2 = RIGHT CONTROL

O1 = LEFT OUTPUT

O2 = RIGHT OUTPUT



SERRATED FITTINGS FOR  
.125" FLEXIBLE TUBING



## PLASTICS FLOGUN

While many of today's electrical and electronic equipments are repairable in the field, one of the main problems remaining is the provision for re-insulating broken or damaged lines or connections. With this problem in mind Canadian Aviation Electronics have developed a piece of equipment which meets such a requirement.

The Plastics Flogun is a portable injection moulding machine weighing  $3\frac{1}{4}$  lbs. (1.5 kg.). It operates at a pressure of 2250 lbs. p.s.i. (1020 kg. per  $\text{cm}^2$ ) to 6900 lbs. p.s.i., (3130 kg. per  $\text{cm}^2$ ) and is designed primarily as a portable tool rather than a high volume production machine. The capacity of the Flogun is 1.1 cubic inches (18.03 cc.) or approximately  $\frac{3}{4}$  of an ounce (21.2 gm), depending on the type of thermoplastic material being used.

Because the Flogun operates at such a low moulding pressure, moulds are unusually light and inexpensive, and pre-heating is generally not required. A universal mould holder is available for use with the Flogun.

The Flogun has numerous applications besides injection moulding. It can be used for welding thermoplastics by simply changing the nozzle. It can be used for extruding. It can also be used for encapsulating wire joints, and repairing damaged insulation on wiring, by using a shuttle mould or a Wire Insulation and Encapsulation Tool, accessories made specifically for use with the Flogun.

The Plastics Flogun is available for use with either 110V 60 cycle, or 220V 50 cycle current. It can be held in one hand and manually operated, or it can be fitted into a bench fixture when short production runs are desired.

An untrained operator can learn to use the Flogun efficiently for injection moulding, extruding, welding or cable covering and splicing in approximately 30 minutes. Moulding charts supplied with the Plastics Flogun contain all information required.



## IMPACT EXTRUSION COMPONENTS

General Impact Extrusions (Manufacturing) Ltd., Toronto, Ontario, specializes in plastic forming and impact extrusion of metals, primarily aluminum, copper, brass and magnesium. It is Canada's largest manufacturer of aluminum impact extrusions. The company's fabrication capabilities include collapsible tubes, vials, mailing containers and other lithographed parts for the packaging industry. The company also produces components for the appliance, automotive, electronics and atomic fields.

For many years General Impact Extrusions has produced parts and components for defence applications, such as pistons, ammunition shells, missile parts, rocket components, precision cold forgings, and tail fin assemblies. A competent engineering staff is available for component and part design.

The impact extrusion process cold forms metals under high pressures. The method is a most efficient way to produce cans, shells and other hollow shapes. It is a high output process ideally suited to satisfy not only military requirements but also the high volume requirements of the packaging, electronics and automotive industries. Press capabilities for impacts are up to 6" (15.24 cm) diameter in lengths of up to 25" (63.5 cm) and for precision forward extrusions, up to 2.5" (6.4 cm) diameter in lengths of up to 120" (3.0 m) maximum.

The company also handles research and development work and has helped to pioneer a number of new applications of the impact extrusion process both in commercial and in military fields.

## GEARING

The assembly on the facing page is indicative of the type of work carried out by York Gears Ltd., who are manufacturers of power transmission systems, sub-assemblies and precision parts for the aircraft industry. This firm on a production basis supplies a full range of gears including spur, helical, spiral, bevel and zerol types which have been used in the J-85 and GE610 jet engines as well as gear boxes for the DHC-5 Buffalo aircraft.





## CHAIN BEAM LOADER

Developed, engineered and manufactured at Fairey Canada Limited's plant at Dartmouth, Nova Scotia, the "Fairlift" brings a new versatility and flexibility to the field of materials handling.

This ingenious chain beam loader requires only 16 in. (40.6 cm) of space between cab and body of any standard truck for installation, leaving truck payload unaffected.

The chain link beam is retractable into a 30 in. (76.2 cm) diameter magazine and can be extended by means of the hydraulic motor to a length of 14 ft. (4.3 m). The lifting capacity of the beam is as follows:

14 ft. (4.3 m)	2500 lb. (1134 kg)
9 ft. (2.7 m)	3750 lb. (1701 kg)
7.5 ft. (2.3 m)	4400 lb. (1996 kg)
5 ft. (1.5 m)	6250 lb. (2835 kg)

The "Fairlift" can traverse 360°, plus 7-½° overlap in either direction.

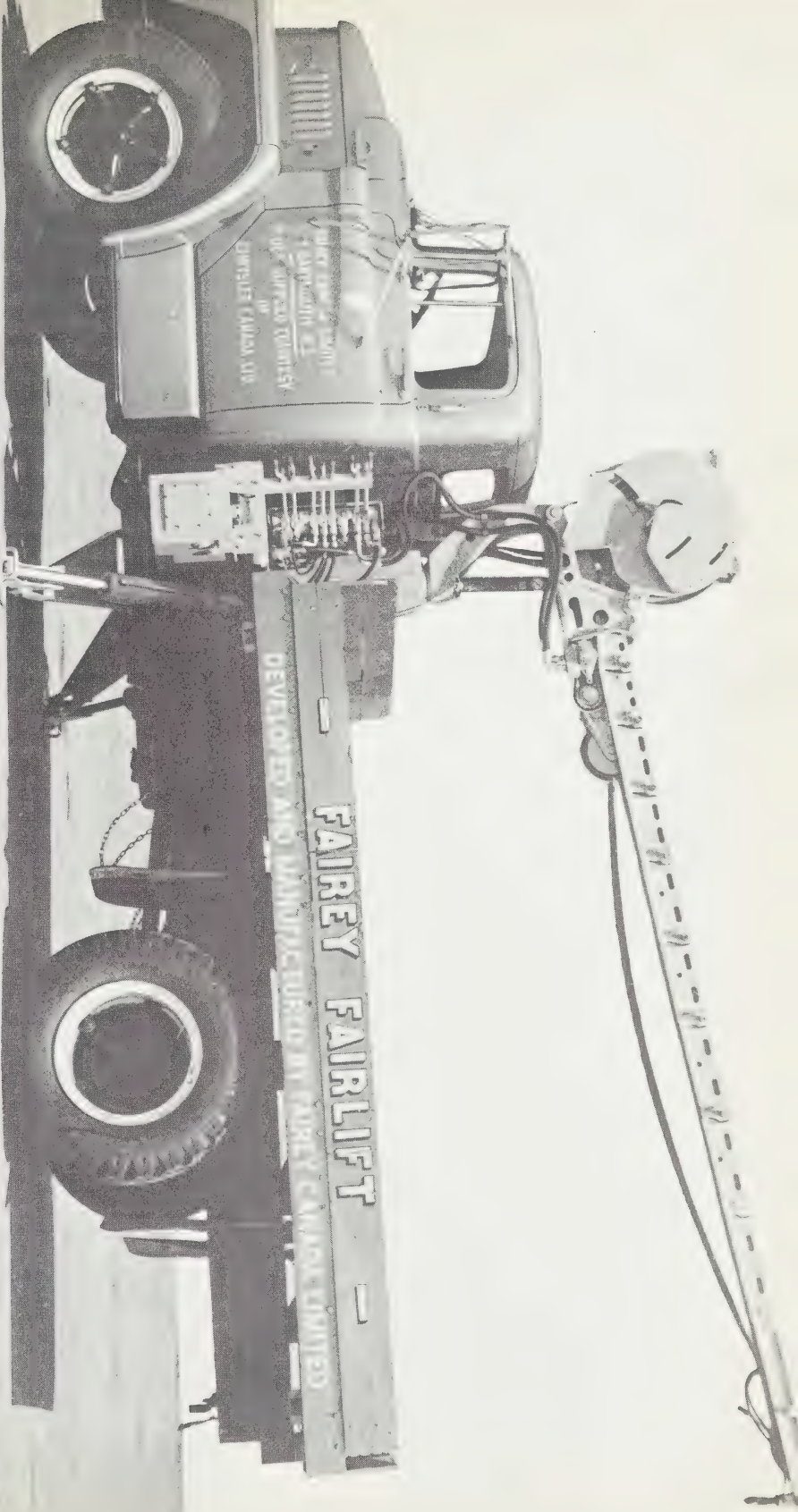
All areas are easily accessible for loading and unloading to a height of 20 ft. (6 m) above ground (without extension boom) and a reach of 14 ft. (4.3 m) radius.

The beam end accepts a large variety of accessories such as Personnel Boom and Basket, Back Hoe, Power Shovel, Log Grapple, Earth Auger, Hydraulic Clam, Power Shovel and Stump Saw. Remote Controls, Dual Controls plus other accessories to the customer's specific requirements can be supplied.

Zero back lash traversing is accomplished by two hydraulic rams attached to roller chains, mounted in the base structure under the main column. The base unit is mounted in bronze bearings providing maximum life and maximum turning ability under load. Chain Links and all moveable parts are provided with grease fittings for efficient maintenance and optimum operation.

"Fail-Safe" operation has been accomplished by the incorporation of a sealed relief valve in the elevating cylinder to prevent overloading, check valves to lock the elevating cylinder and extension motor if the hydraulic pressure should fail, or the operator attempt too quick lowering of the load, and precision hydraulic control valves to allow complete speed control.

The entire equipment has been designed for single operator control. The three basic control levers controlling elevation, extension and traverse are located on the left side of the truck. Right side and electrical remote control accessories are available. Provision is made for four additional control levers for accessories.





## LOW GROUND-PRESSURE TRACKED CARRIERS

Originally developed to permit year-ground seismic survey and oil explorations in the muskegs of Canada and Alaska, the Nodwell tracked carrier has been used as an off-highway vehicle around the world. In addition to transporting heavy equipment, entire crews and work camps are carried in specially designed units — mobile sleeping quarters, kitchens, diners and portable workshops.

Nodwell units perform a wide variety of jobs, in all areas of the globe, including personnel carriers, logistic carriers, recovery vehicles, tankers, crash rescue vehicles, fire-fighters, amphibious carriers and numerous other military and commercial uses.

There are five basic vehicles as follows:

MODEL NO.	PAYLOAD	G.V.W.	GROUND PRESSURE	
			UNLOADED	LOADED
RN 25	2,500 lbs. <i>1134 kg.</i>	11,000 lbs. <i>4989.6 kg.</i>	1.40 psi <i>39.7 grm/645 mm²</i>	1.82 psi <i>51.6 grm/645 mm²</i>
RN 75	7,500 lbs. <i>3402 kg.</i>	17,500 lbs. <i>7938 kg.</i>	1.28 psi <i>36.3 grm/645 mm²</i>	2.29 psi <i>64.9 grm/645 mm²</i>
RN 110	11,000 lbs. <i>4989.6 kg.</i>	23,000 lbs. <i>10,432.8 kg.</i>	1.1 psi <i>31.2 grm/645 mm²</i>	2.1 psi <i>59.5 grm/645 mm²</i>
RN 150	15,000 lbs. <i>6804 kg.</i>	32,330 lbs. <i>14,664.9 kg.</i>	1.40 psi <i>39.7 grm/645 mm²</i>	2.59 psi <i>73.3 grm/645 mm²</i>
RN 200	24,000 lbs. <i>10,886.4 kg.</i>	71,500 lbs. <i>32,432.4 kg.</i>	1.7 psi <i>48.2 grm/645 mm²</i>	2.6 psi <i>73.7 grm/645 mm²</i>

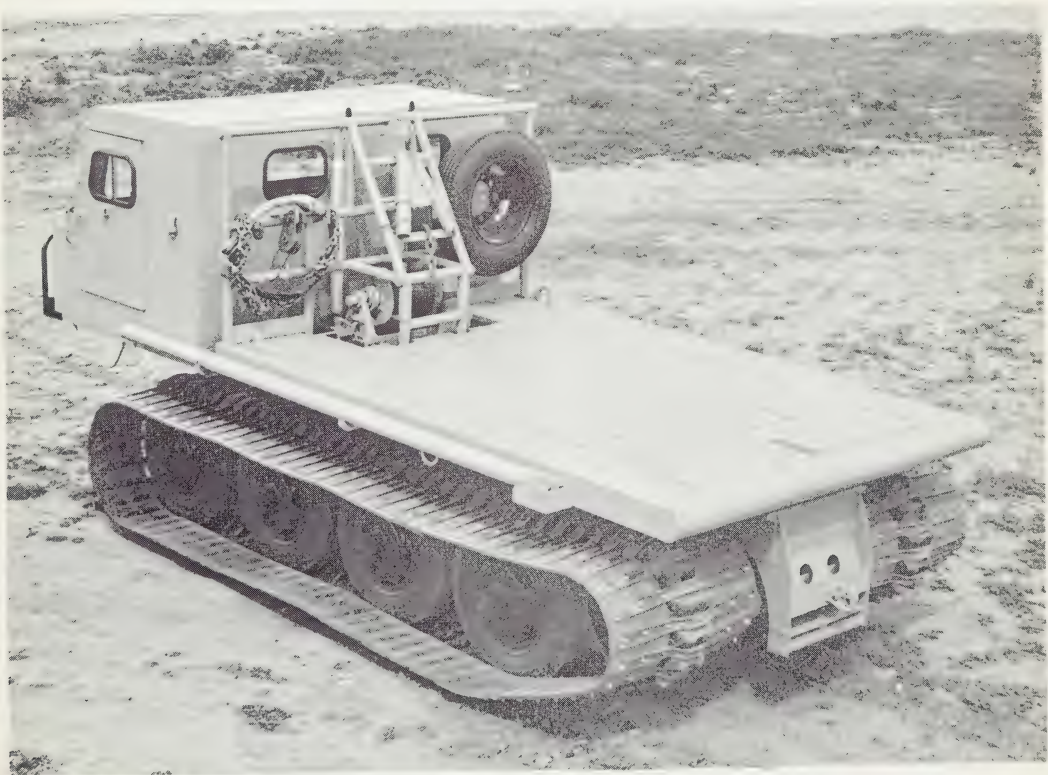
Through a principle of flotation, the full load weight is evenly distributed, at low ground pressure, over the broad area which is covered by the wide, endless tracks of rubber and steel. The vehicles are engineered for a forward gradeability of 60% and a side gradeability of 30%.

The two largest units are equipped with front and rear tracks, powered by independent engines. Multi-axle tracked trailers are also available for the larger units.

A wide variety of options is available with all models to ensure that Nodwell carriers have a role in the expanding requirements of frontier developments around the world.



Model RN 110 as a Personnel Carrier.



Model RN 110 with 15,000 lb. (6804 kg.) Winch.

## “DYNATRAC”—(XM-571)

Canadair Limited has designed and developed an extremely versatile tracked vehicle—the Dynatrac. The U.S. Army, who have an interest in this vehicle designate it as the XM-571.

The Dynatrac is a fully tracked, articulated, high mobility, utility carrier with a payload capacity of 2,000 pounds (907 kg) plus driver and co-driver. The vehicle is designed to be used as a cargo or personnel carrier, as a litter evacuation unit, as a platform for a series of light weapons systems and for a variety of other uses such as common post, liaison, scouting and wire laying.

The Dynatrac's swimming ability permits it to cross inland water bodies without special preparation. It will operate at high altitudes and under conditions of driving rain, snow or dust and in temperatures ranging from  $-65^{\circ}\text{F}$  to  $+115^{\circ}\text{F}$  ( $-18\text{C}$ . to  $+46\text{C}$ ).

The Dynatrac's exceptional off-road performance is largely the result of a combination of the following unique features: **LOW GROUND PRESSURE**—The fully loaded vehicle has a mean ground pressure, at no sinkage, of about 2 pounds per square inch reducing to about 1.5 pounds per square inch at four inches sinkage. This has been achieved by the maximum use of low density, high strength materials. **HIGH TRACTIVE EFFORT**—A high tractive effort to gross weight ratio of greater than 1:1 is obtained by the use of a high performance engine, suitable gear ratios, and low structural weight. The vehicle can negotiate steep slopes or pull heavy loads with equal ease. **ALL TRACKS POWERED**—Each track of each unit is powered by the engine in the front unit. Over ridges, in ditches, in mud or deep snow, regardless of carrier attitude, optimum tractive effort is produced. Linked hulls prevent “nose high” trim when the Dynatrac is underway, thereby maintaining full traction. **ARTICULATED STEERING**—By using hydraulic actuators to deflect one unit in relation to the other, steering forces are kept within the structure and are not transmitted to the ground. This reduces “bog-down” hazard, a major disadvantage of conventional tracked vehicles when operating in swampy areas.

Whenever required, the front unit may be operated alone. In this case, steering of the unit is accomplished by a conventional clutch-brake system. Front and rear units can be separated or connected in less than two minutes without special tools.

The Dynatrac, with full payload, is transportable by medium helicopter. In addition, the front and the rear units with their respective payloads are individually transportable by light helicopter.

The Dynatrac's design permits the addition of a third articulated unit which is powered in the same way as the second unit. The third unit will carry a 1500 pound (680 kg) payload, increasing the vehicle's carrying capacity to a total of 3,500 pounds (1590 kg) plus driver and co-driver. With three units connected, the Dynatrac retains its high off-road mobility and its performance is virtually unaffected under normal cross-country conditions.

Economy of operation, ease of maintenance and reliability have been designed into the Canadair Dynatrac making it one of the most versatile and highly mobile vehicles in its class today.





## OFF-HIGHWAY TRACKED CARRIERS

Bombardier offer a variety of models of the type illustrated, using the same basic vehicle, and each incorporating special features required by the particular application.

With double width tracks and greater flotation, the vehicle can carry payloads of 6,000 lbs. over rough terrain, soft soil and through swamps. The 125 HP Chrysler engine gives plenty of reserve power for high gear operation over tough terrain.

The standard but unique Bombardier flexible suspension is incorporated in the vehicle and speeds of up to 25 MPH are attainable. Unloaded ground pressure is around 1.0 p.s.i., the total weight of vehicle varying from 4000 to 6000 lbs. dependent upon the role for which it is designed.

Some of these roles are:—

*'Muskeg Carrier'* — an all purpose carrier, fitted with cab and used for transportation of men, materials and equipment over snow, ice and the softest soil.

*'Muskeg Tractor'* — Shown in the illustration. Can be adapted for fire-fighting, logging, ski-slopes, as a dozer, grader, back hoe and many other applications. As an option, a 190 HP — V8 engine is supplied, and an 11 ft. tracked tractor is also available.

*'J5 Tractor'* — This is a smaller version (only 3 roadwheels instead of 4) and is illustrated on the opposite page. Versatility is the keynote of this model, which is ideal for logging, ranching, recreation, fire-fighting, conservation, construction, snow removal, transmission, pipe line work, etc. A small tracked trailer is available.

*'RAM Skidder'* — This is similar to the J5 but is also equipped with 10,000 lbs. winch and hydraulic dumping platform.

All these vehicles are stock production items and are in current use in 32 different countries.







## HEAVY-DUTY CONSTRUCTION VEHICLES REAR DUMP TRAILER

The rear dump trailers manufactured by Atlas Hoist and Body Inc. have been developed for use in heavy construction and mining operations.

Payload capacities vary from 30 tons to 65 tons (20 cu. yds. to 40 cu. yds.), each trailer being designed to suit a specific application. Depending upon the application, they are fabricated of either ultra-high strength, heat-treated steel or of aluminum. They can be coupled to all makes of rubber-tired tractors and operate as integrated units.

The wide body offers easy loading, and the robust construction permits the unit to be operated under rugged conditions.

The single axle on the trailer makes it possible to turn on a road bed of less than 36 feet (10.9 m) but the vehicle is also capable of relatively high road speeds.



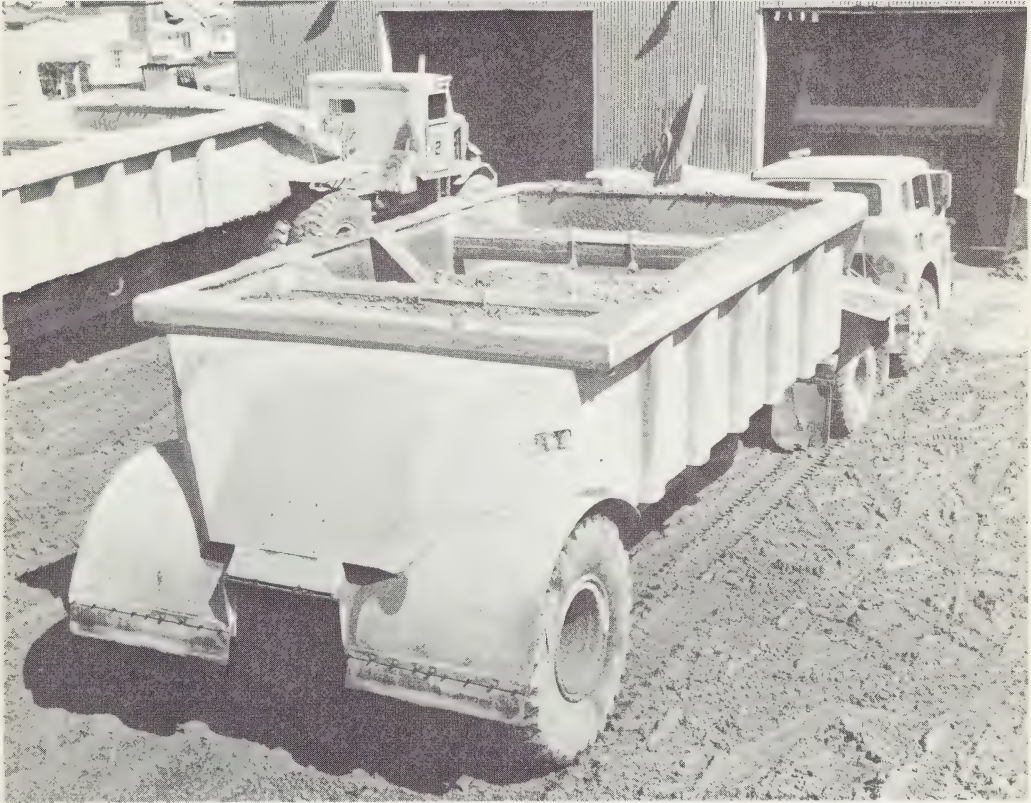
## HEAVY-DUTY CONSTRUCTION VEHICLES

### BOTTOM DUMP TRAILERS

Atlas Hoist and Body Inc. manufactures a line of bottom dump trailers with some models suitable for off-highway and others for on-off-highway. Depending upon the application, these units are fabricated for either steel or aluminum.

They are designed to be hauled by any make of on or off-highway tractor, and are manufactured in payload capacities up to 120 tons. Where highway use is involved, these trailers are designed to operate within the required dimensional and weight limitations.

There are twin hopper units with air-operated clam shell doors which open smoothly to dump the load quickly and efficiently. With the load dropped in windrows, the grader can quickly level the aggregate to form a smooth road bed.



## LIGHT-WEIGHT RECONNAISSANCE VEHICLE (SNOW)

The small snow vehicles depicted on the opposite page (Olympique in the foreground and Alpine in upper left) are the smallest of a series of over-snow vehicles designed and produced by Bombardier Snowmobile Ltd. They are a derivative of the world's first snowmobile which was produced by Bombardier over 40 years ago and which has been in operation throughout the world for 30 years.

The chassis is of steel monopiece construction with the cowling of reinforced fiberglass. The track is tough, flexible rubber, reinforced with internal steel bars, the sprockets are rubber covered.

A partial list of the general specifications of these vehicles are as follows:

### Super-Olympique

82 in. (208 cm)

96 in. (244 cm)

31.5 in. (80 cm)

31 in. (79 cm)

One endless

15 in. (38 cm)

50 in. (127 cm)

14 rubber

2

Tandems & Springs

265 lbs (120 kg)

1020 sq. in. (6581  
sq. cm)

.26 lb/sq. in. (108.9  
gm/sq. cm)

48 mph (77 kilo/hr)

2

3 Imp. Gal. (13.63 lit.)

.75 gal/hr. (3 lit./hr)

1 cylinder, 2 cycle air  
cooled, 300 cc

Length of Chassis

Overall Length

Width of Chassis

Height

Track

Track Width

Track on Ground

Track Supporting Wheels

Drive Sprockets

Suspension

Weight

Bearing Surface

Ground Pressure

Maximum Speed

Seating Capacity

Fuel Tank Capacity

Gas Consumption

Engine

### Alpine

81 in. (206 cm)

96.5 in. (245 cm)

36 in. (91 cm)

36.5 in. (93 cm)

Two endless

15 in. ea. (38 cm ea.)

50 in. (127 cm)

28 rubber

4

Tandems & Springs

395 lbs. (179 kg)

1790 sq. in. (11,638  
sq. cm)

.21 lb/sq. in. (95 gm/  
sq. cm)

35 mph (56 kilo/hr)

2

5 Imp. Gal. (22.7 lit.)

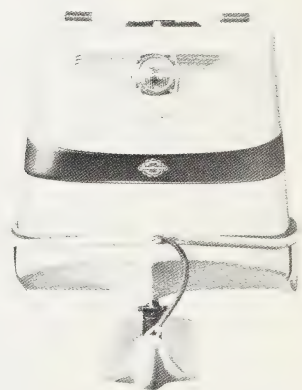
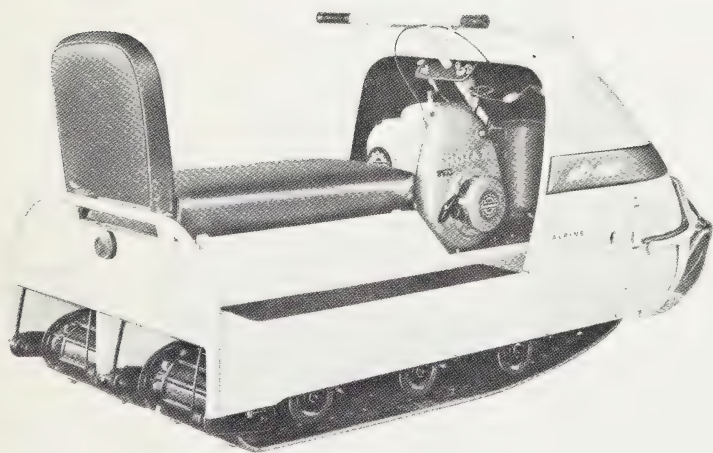
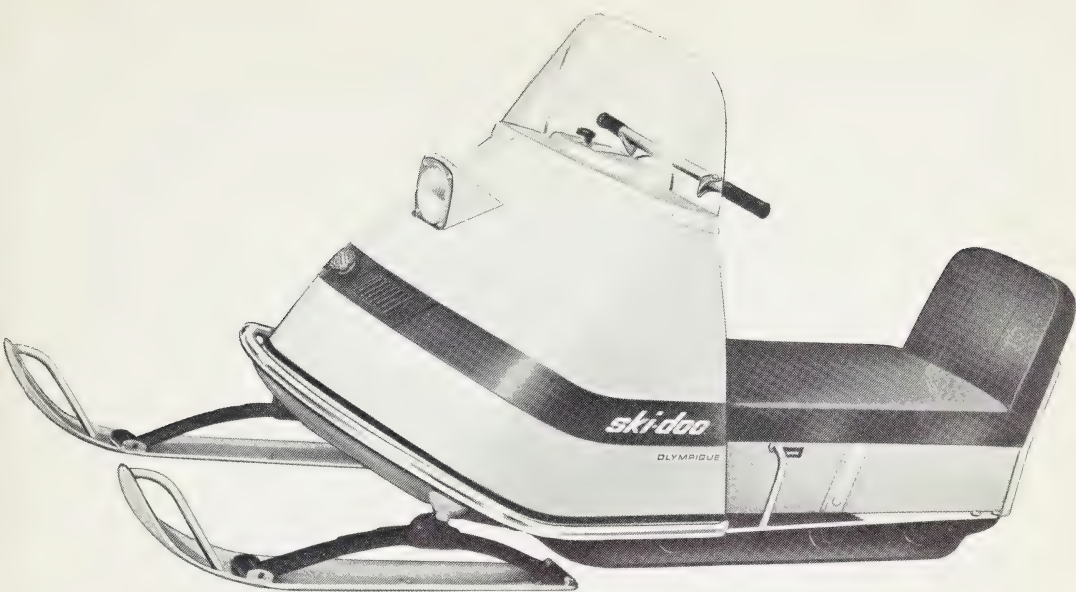
.75 gal/hr (3 lit./hr)

1 cylinder, 2 cycle, air  
cooled, 300 cc

It is considered that these vehicles are about as light as a ground traction vehicle can be and yet withstand the punishment that 45 mph (72.5 km/hr) over packed snow or ice will inflict. The uses of the vehicles are as varied as one's imagination and requirements. The rapid movement of forward survey parties, communications groups, couriers, scouts or patrols are all possible with such equipment. The Olympique with the single endless track and narrower chassis would tend to support a high speed scouting or courier role while the Alpine with the double track and wider chassis would lend itself to more utilitarian roles.

The constant development of this type of vehicle at Bombardier has taken a vehicle which was primarily considered an item of sport and placed it in the category of an equipment which can be relied upon for the most exacting of tasks.





## SNOW VEHICLES

### **SW Snowplow**

The compact Bombardier SW is only 48 inches (1.2 m) wide but is capable of snow clearance with V-plow, one-way plow or pusher blade. It is easy to operate, has excellent all-round visibility and is equipped with a warm, comfortable cab. Originally designed as a side-walk plow, it has been used extensively in camp sites and other limited access area.

Fitted with Chrysler Industrial 251 engine, it has a top speed of 25 mph (40 Km/hr). Tracks are 5" (12.7 cm) rubber belts with heavy duty steel cross-links. The suspension and track system is the standard Bombardier principle which has been proven through more than 75 years service.

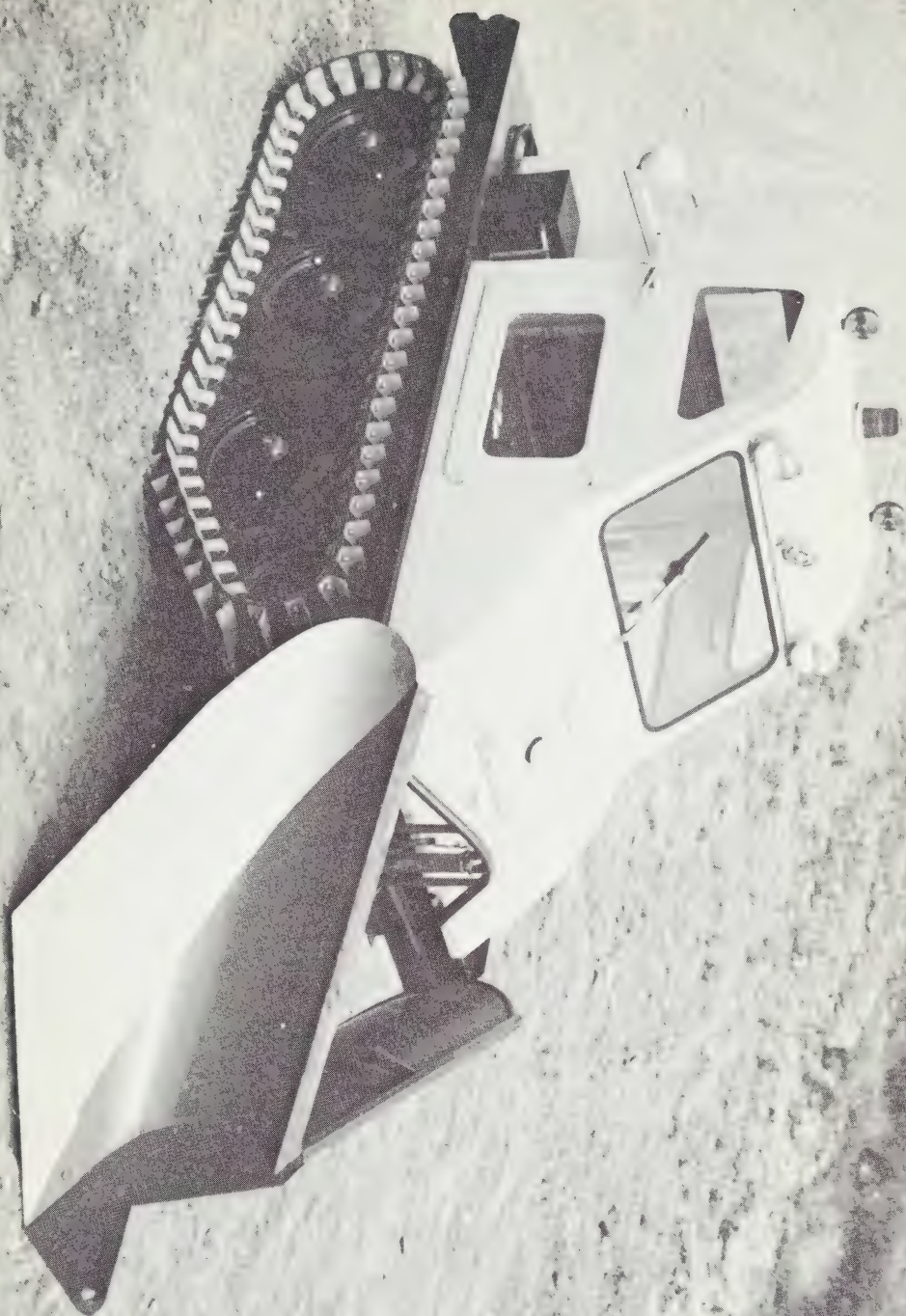
### **Snowmobile**

These vehicles are helping to solve the winter transportation and travel problems around the world. The vehicle comes either fitted with front wheels or with 60" x 12" (1.5 x .3 m) skis for over-snow use.

It is powered by a 145 HP V.8 Chrysler engine and is capable of top speed 45 mph (72 Km/hr), with cruising speed of 25-30 mph (40-48 Km/hr). The standard model is designed to carry 15 passengers.

Amongst some of the uses to which the vehicle has been put are:—

Ambulance over snow; winter school buses; general transportation (can be hitched to a sleigh); rescue work in snowstorms; postal service in isolated communities; public utilities (off-highway); prospecting; arctic expeditions.





## LIGHT-WEIGHT SMALL ARMS AMMUNITION PACK

Small Arms Ammunition, because of the enormous quantities used, has always presented grave logistical problems such as transportation, adequate packaging, water-proofing, man-portability and costs, to name but a few of the more paramount considerations.

With the creation of new and better materials and techniques it became possible to give consideration to the successful solving of some of the mentioned problems provided the shibboleths of old designs were discarded and full advantage was taken of new materials and the permissive designs admitted by them.

This is what was accomplished by the Canadian Army and Industry when the new light-weight pack was introduced. After considerable development and trial a plastic bandoleer was produced which provided in its material, as an inherent feature, the moisture protection so long sought but never achieved by older packs.

The bandoleer comprises six injection moulded polyvinyl-chloride pockets which are heat sealed to vinyl coated nylon cloth which has as an extension two tapes of the same material to allow the comfortable positioning and fit of the bandoleer over all types of equipment and clothing. The plastic pockets, designed for the NATO 7.62 mm round, are approximately  $3\frac{3}{8}$  in. by  $2\frac{3}{4}$  in. (8.8 cm by 7.2 cm) and contain two 5 round clips, so that sixty rounds are carried in each bandoleer. As each pocket is an individual unit, the ammunition is continually protected from moisture until required.

With the development and acceptance of the new bandoleer it was now possible to give consideration to a much lighter and less costly outer package. The old case, weighing some 83 pounds (37.6 kg), was of wood with a sealed metal liner for protection against moisture. This seal was good only for as long as it remained unbroken. Once broken, the entire contents of the case were open to moisture. This case was usually considered an accountable item due to its high cost and was back loaded for re-use, occupying as much shipping space empty as when full.

The new lighter pack, containing 480 rounds, was produced from a special type of solid fibreboard with a carrying handle and quick tear-open feature and weighing 33 pounds (14.9 kg). Two of these packs are incorporated in a light outer case having the same quick opening feature but employing two handles for portability. The whole case weighs 69 pounds (31.2 kg.).

The main case, designed with a view to warehousing, also has been designed to fit on the standard pack board as a one man load or may be transported as a balanced load by breaking open the outer case and carrying one pack in each hand. Due to the materials used and the costs involved the entire packaging unit is considered disposable, with obvious savings. In manufacture alone the cost reduction is over 5%, with the main saving being embodied in the disposable feature.



## **SIGNAL UNDERWATER SOUND MK 400 AND MK 401**

These are single source explosive sound signals used in combination with sonobuoys for the detection of underwater intruders. They may be dropped from aircraft by hand or through launchers and also over the side of ships to discourage underwater saboteurs.

The stores are designed to provide optional depth functioning for shallow or deep setting and the latter can be produced to provide any depth requirement between 330 and 800 feet (106 m and 244 m).

There are two versions available, the Mk 400 being High Explosive 1.8 lbs. (820 gms) for operational use and the Mk 401 Reduced Charge 1 oz. of Explosive (28.3 gms) for practice use. The two types are identical in weight and overall dimensions and can be used with the same equipment.

The store has double safety provision, being locked in a safe position until just prior to launching and subsequently armed by hydrostatic pressure. The functioning at the depth selected prior to launch is also by hydrostatic pressure.

The units may be carried in storage racks in aircraft or ships and with a minor modification may be adapted for carriage in racks or pods under aircraft wings.

The store was developed by the Canadian Armament Research and Development Establishment (CARDE) and has been in volume production by Canadian Arsenals Limited for the Canadian Services. This equipment has been adopted by U.K. and is on trial in Australia and West Germany.

## **MARKER LOCATION MARINE MK. 25, MOD. 2.**

The Marker Marine Mk. 25 is a Pyrotechnic store, which provides both smoke and flame while floating in the water. It is used to determine the drift of aircraft while flying over water and as a visual indicator in anti-submarine exercises. It is launched from the Retro-launcher of the aircraft but may also be carried under the wings or may be dropped from helicopters or over the side of ships. The unit operates for minimum of 13.5 minutes and provides a visual indicator for both day and night.

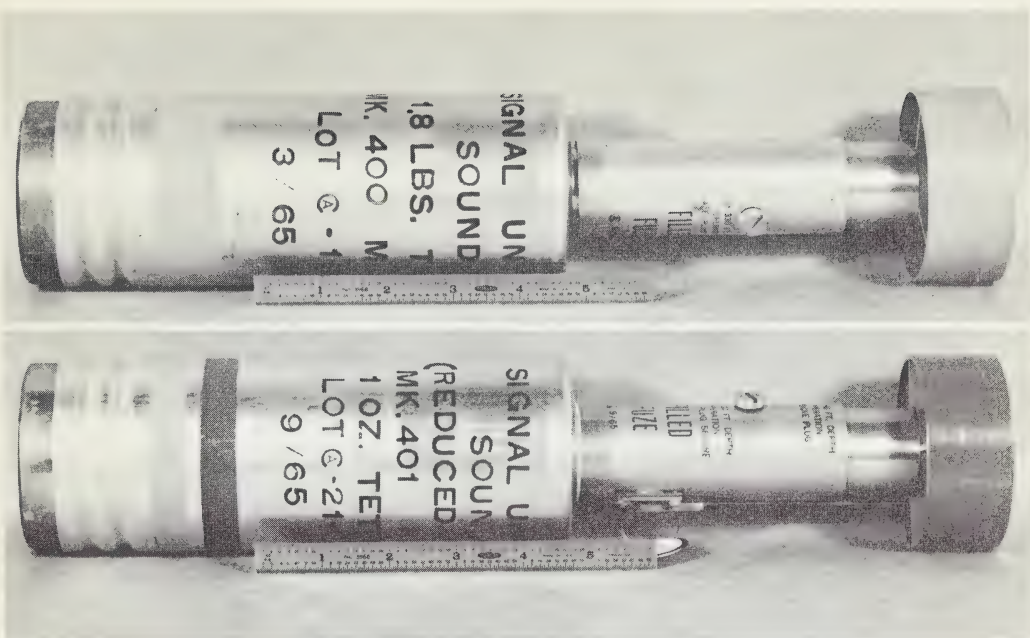
Flotation orientation in the vertical plane is obtained by the integral volume of air and the position of the centre of gravity. Actuation is by sea-water cells and electric squibs, which ignite the starter mix and thereby the Pyrotechnic charge. Initiation takes place a very short period after impact with the water.

The dimensions of the store are 2.99 inches (7.5 centimetres cm) diameter and 18.5 inches (46.9 cm) long with a weight of 4.5 pounds (2.0 kg). The stores are packaged six per water resistant fibre container suitably reinforced.

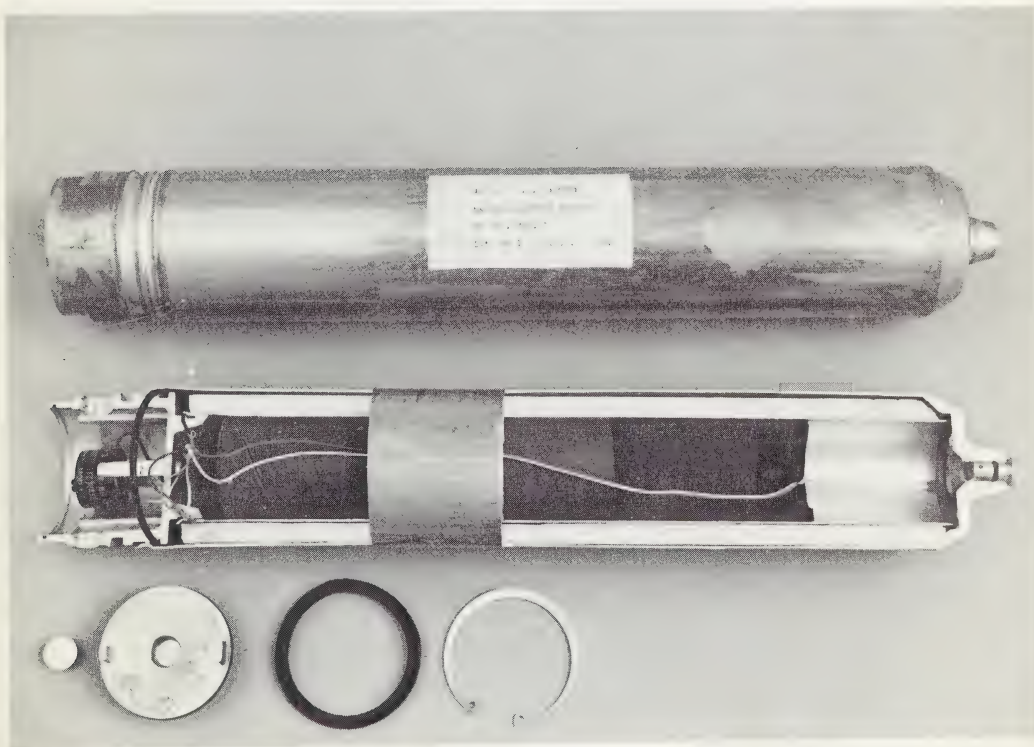
The design offers an improvement over the Marker Marine Mk. 7, which it replaces, due to the replacement of the wooden body by an extruded aluminum case, which provides built-in flotation. The initiation by electric squibs results in a more reliable firing train. It is estimated that the increase in burning time and generation of smoke over the Marker Marine Mk. 7 will permit a reduction in operational requirements in a ratio of 2 to 3 or better.

This equipment has been adopted by the Netherlands government.





**SIGNAL UNDERWATER SOUND MK 400 AND MK 401**



**MARKER LOCATION MARINE MK. 25, MOD. 2**

## **MINE ANTI-PERSONNEL NON-METALLIC C3/M25**

These mines were developed by the Canadian Army and have been accepted as standard by ABCA countries. The C3 version contains an aluminum shell 6 gr detonator while the M25 contains a gliding metal shell M46 detonator. The two versions are otherwise identical.

It is a low cost plastic groundburst mine supplied in two principal assemblies, consisting of the body assembly, 2" diameter by 3" long (5x7.5 cm) with a weight of 2 oz. (57 gm), and a charge assembly, 1.5" long by 2.2" diameter (3.8 x 5.6 cm) with a weight of 1 oz. (28 gm). The total weight of the explosive is 9.45 gm.

The body assembly has a transit plug, which is removed after the body assembly has been emplaced and replaced by the charge assembly, fitted with a safety clip. Removal of the safety clip prepares the mine for function, under a load of 16 to 26 lbs. (7.25 — 11.8 kg). As long as the safety clip remains in place, much greater loads will not cause actuation.

The Mines are coloured olive drab and are designed with camouflage to blend into the local ground colour.

Emplaced mines, after removal of the safety clip, are operationally undetectable, with conventional detection equipment. A detector ring can be fitted, if this should be required, which makes the mine detectable by standard methods.

The operational use is to protect positions to prevent the lifting of anti-tank mines and to deny terrain to attacking forces. The mine has been loaded by Canadian Arsenals Limited, Filling Division with components supplied from various sources.

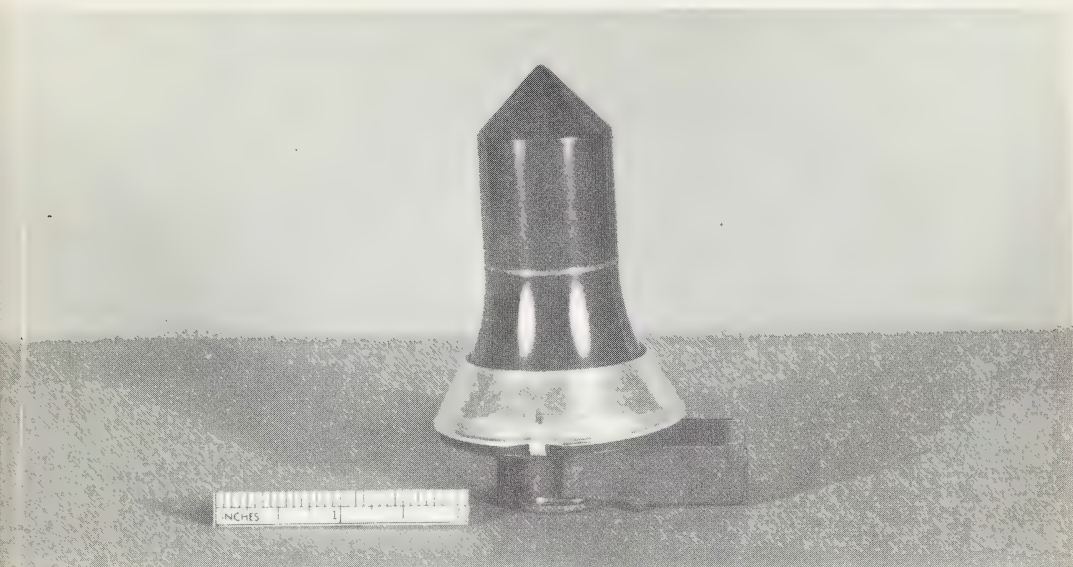
## **MINE ANTI-PERSONNEL NON-METALLIC PRACTICE C4**

The mine is a practice version of the C3/M25 H.E. mine with the exception of producing a cloud of blue smoke on actuation.

The emplacement assembly and function of the practice mine is otherwise the same as for the H.E. version.

It is constructed of plastic materials and is reusable at least five times by replacement of the spotting charge and the recocking of the body assembly.

The item has been in volume production for the Canadian Forces by Canadian Industries Limited and other contractors.



**MINE ANTI-PERSONNEL NON-METALLIC C3/M25**



**MINE ANTI-PERSONNEL NON-METALLIC PRACTICE C4**





## HELICOPTER TRANSPORTABLE HOUSING FACILITIES

The cube facilities shown in the photograph on the opposite page are air transportable and may be complexed into a large kitchen, washroom, generators and other such equipment. Cube weights are designed so the maximum lift is approximately 3500 lbs. (1587 kg).

Cube construction is lightweight using sandwich panel design. Foam core with plywood or aluminum skins can be provided. The cubes are designed to operate in environments of  $-100^{\circ}\text{F}$  ( $-37.7\text{C}^{\circ}$ ) and 100 mph (161 k) winds, and have been used successfully in environmental conditions of  $-130^{\circ}\text{F}$  ( $-90\text{C}^{\circ}$ ) in the Antarctic.

The cubes have been designed for knocking down and palletizing to reduce shipping volumes. Special fasteners, seals and joining devices have been incorporated into the design to insure transportability and sure sealing.

Special cubes have been designed and are in use which expand from a floor area of 150 sq. ft. ( $12.8\text{ m}^2$ ) to 330 sq. ft. ( $30.9\text{ m}^2$ ). These expandable cubes have all the necessary mechanical equipment (water storage, pumps, stoves, washbasins, etc.) installed in the fixed part of the cube. The expandable part of the shelter is used for sleeping or dining areas. The equipment (beds, tables, etc.) used in the shelter are a fixed part of the shelter and normally fold up into the walls. These expandable units are designed with a base so the units have the capability of being mounted on wheeled or tracked vehicles.

ATCO Industries of Calgary, Alberta, have provided these lightweight, highly mobile complexes to both government and community agencies on numerous occasions.

## TRANSPORTABLE HOUSING COMPLEX

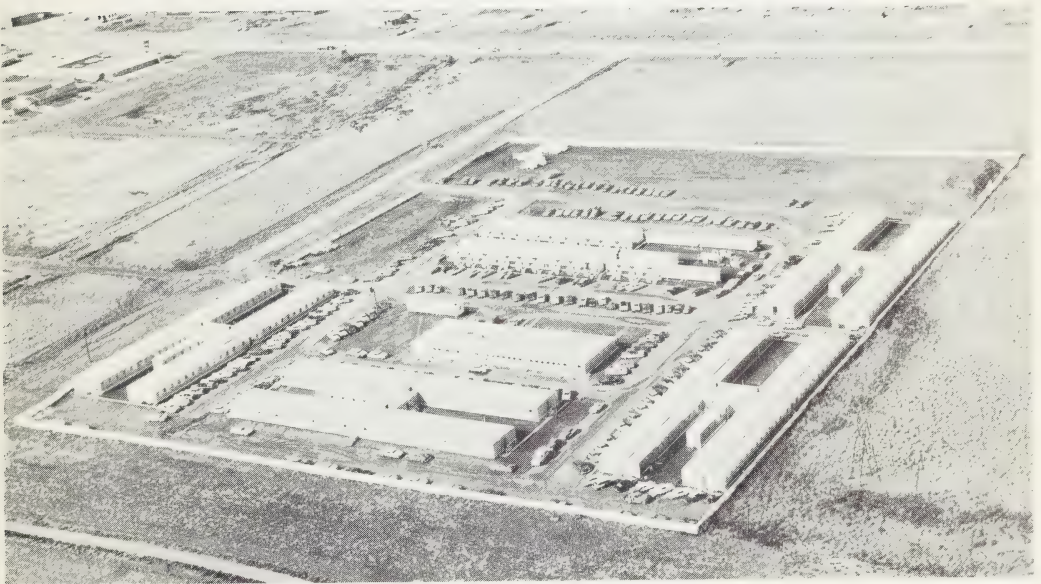
The trailer complex shown on the opposite page provides complete living, kitchen, dining, washroom and office space. ATCO Industries provide complexes in modular form. The individual units may be easily complexed into larger single story or three story facilities. Units are complexed so hallways are continuous from end to end of the complex as in a hotel or apartment. Standard modular units are 10 ft. wide and 40 ft. and 50 ft. long ( $3.04 \times 12 \times 15.2\text{m}$ ). Units are provided with wheels or skids for traversing rough terrain.

Large open areas free of posts can be provided since 30 ft. (9 m) free spans are common in the trailer design. By complexing three 10 ft. (3.04 m) wide units side by side, open areas for dining, recreation or offices of 1500 sq. ft. (139 m<sup>2</sup>) are possible.

The complexes are designed for loading in C-130 aircraft and custom designs are designed for knocking down to reduce shipping volumes in aircraft or for water transportability.

Construction is normally wood frame, steel chassis and aluminum exterior skins; however, complete aluminum structures are available.

Currently modular concepts are being used by ATCO Industries of Calgary, Alberta, to fabricate two 100-bed hospitals for overseas military use. These hospitals can be re-located in rear areas for medical support.



# CANADIAN ARSENALS LIMITED

## (Small Arms Division)

The Small Arms Division of CAL has provided the Canadian Armed Services with equipments and designs consistent with the exacting demands of ordnance work where consistency and long life to rigorous specifications is taken for granted.

High speed deep-hole drilling, high quantity and accuracy broaching as well as internal chroming facilities are but three of the techniques available at Small Arms which ensure a production in accordance with specifications and to inspection standards.

The very special qualities of any Arsenal and more particularly CAL, as it is a self-reliant and completely self-contained operation, makes it a valuable back-up source to other segments of the defence industry or to industry at large where the peculiar and specialized techniques of any established arsenal are understood. Very often ordnance experience in material and standards provide the positive assurance required in other than what might be normally considered straight ordnance products.

Recent production at CAL has included .50 Brownings, Air and Ground versions; 7.92 mm Bren LMG's to foreign account; 7.62 mm (FN) C1 & C2 Rifles; 9 mm C1 (Sterling) SMG's and millions of 20 mm Ammunition Links.

The design services available at SAD have made vast improvements on such standard and internationally recognized weapons as the FN Rifle and the Sterling SMG as well produced the 9 mm Browning pistol (Canadian Pattern HP) which is used as a standard side arm in a variety of countries.

The facilities at the Small Arms Division are of more than ordinary interest, as would be expected, and brief summaries of the more salient features are noted.

### **BROACHING:**

The Broach Department has 13 surface broaching machines which are pit installed to ensure ease of handling material from floor level and are serviced by an overhead crane system to facilitate the handling of heavy broach tooling. The machines range in size from 10 tons (10 metric) with a 66" (1.7 m) stroke to 25 tons (25 metric) with a 90" (2.3 m) stroke and are of the double ram type with both oscillating and shuttle table arrangements thus permitting maximum use of operator's time during the cutting period of the machine cycle. There are also two vertical internal broaching machines with automatic broach pulling and retrieving mechanisms, each machine of the multi-head type. These machines are used for precision broaching of holes, slots and other through-type internally formed shapes. These machines are capable of broaching many shapes in a wide range of sizes restricted only by their tonnage capacities.

### **HONING:**

The Division has considerable capacity for internal honing with a honing machine equipped to hone bores from 1½" to 8" (38 - 203 mm) ID and lengths up to 12 feet (3.7 m). Surfaces finishes are produced in order of 8 RMS (micro finish). Recoil and Recuperation systems on the 105 & 155 mm Howitzers are reworked on this equipment.

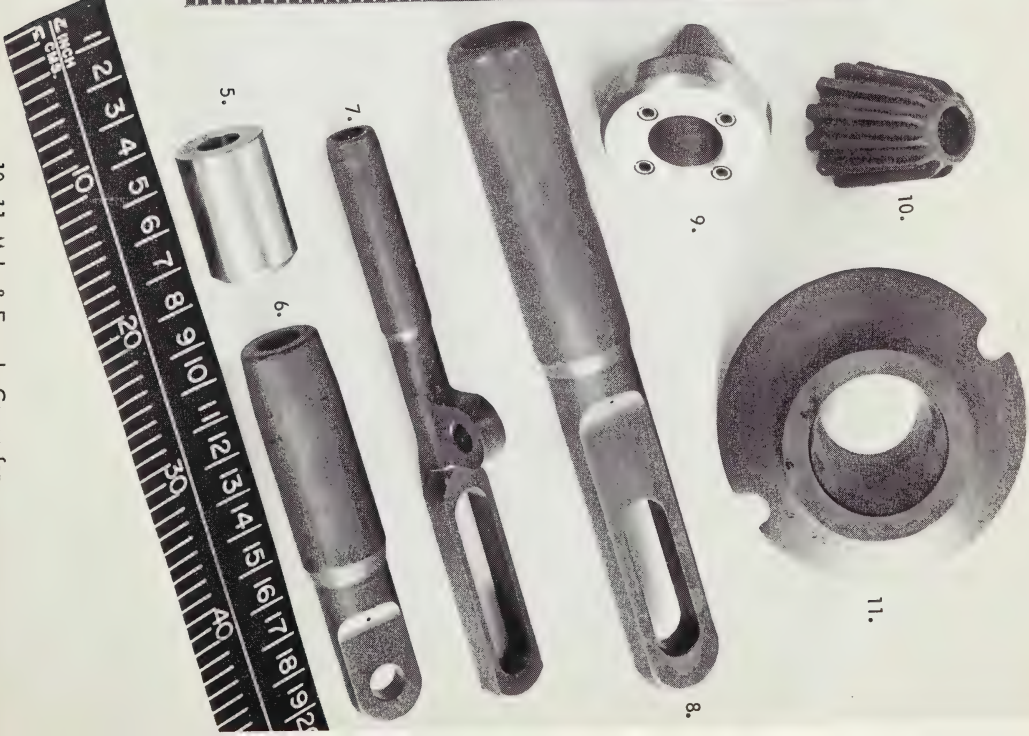
*(Cont'd on page I-246.)*



1-8: Cable Terminals-A/C Arresting Devices  
 9. Piston for Naval Catapult  
 Launching Device



10-11. Male & Female Cones for  
 Pre-Stressed Concrete Construction.



## HEAT TREATMENT AND METAL FINISHING:

For convenience this facility will be discussed under its six specialized departments. It must be remembered that all departments work to demanding ordnance standards.

**Production Heat Treating** — The Heat Treating Department is equipped to handle ferrous metal parts in sizes up to that encountered in weapons as large as 20 mm calibre. The bulk of the heat treatment of finished parts is carried out in atmosphere controlled Lindberg carbonitriding furnaces. Barrel forgings are heat treated in non atmosphere pit furnaces. Induction heating equipment is available in the form of 10 KW and 25 KW units (450 KC) with and without oil quenching facilities. Molten salt and lead baths are available for cyanide hardening, neutral hardening, tempering and nitriding. Facilities are available for the heat treatment of all varieties of tool steels. Support equipment includes automatic atmospheric controls, deep freeze cabinet, magnetic particle inspection and Rockwell, Brinell and Vickers Hardness Testers.

**Electroplating** — A special purpose department equipped for electropolishing and hard chromium plating of gun barrel bores and external plating on a variety of small parts. Support facilities include special bore scrubbing and lapping machines and lead-tin alloy plating for use on special conforming anodes.

**Anodizing and Alodizing** — Sulphuric acid anodizing to Mil-A-8625A type 2 and Alodine Chemical films to Mil-C-5541 are produced in this department. Tank sizes are approximately 30" square by 30" deep (76 x 76 cm) with the exception of the anodizing tank which is long enough to accept three racks at a time.

**Abrasive blasting, Tumbling, Polishing and Buffing** — The abrasive blasting facilities include a Pangborn Rotoblast, Wheelabrator, hand and tumble sand blast. Parts up to 48" (1.2 m) in length are processed. Tumbling facilities used for deburring and burnishing comprise Supersheen Tumbling Machines with compartment sizes up to 30" diameter by 24" (76 x 61 cm) width. Support facilities include storage bins, stone separators etc. The polishing equipment comprises 6 Ford Smith polishing lathes.

**Phosphating and Oxide blackening** — Phosphating is carried out to Mil-P-16232 on parts up to 36" (.9 m) in length. Oxide blackening is carried out to Mil-C-13924 on parts up to 30" (76 cm) in length. Support equipment includes acid and alkali cleaning tanks, rinse tanks, oiling benches etc.

## METALLURGICAL AND CHEMICAL LABORATORY:

This laboratory is responsible for the composite quality control of all incoming raw materials as well as in plant control over all chemical and metallurgical processes. Chemical facilities are mainly volumetric and gravimetric for metal analysis and processing solution control. The Metallurgical Laboratory is equipped for tensile testing, impact testing, hardness testing, metallograph and salt spray testing.

*(Concluded on page I-248.)*



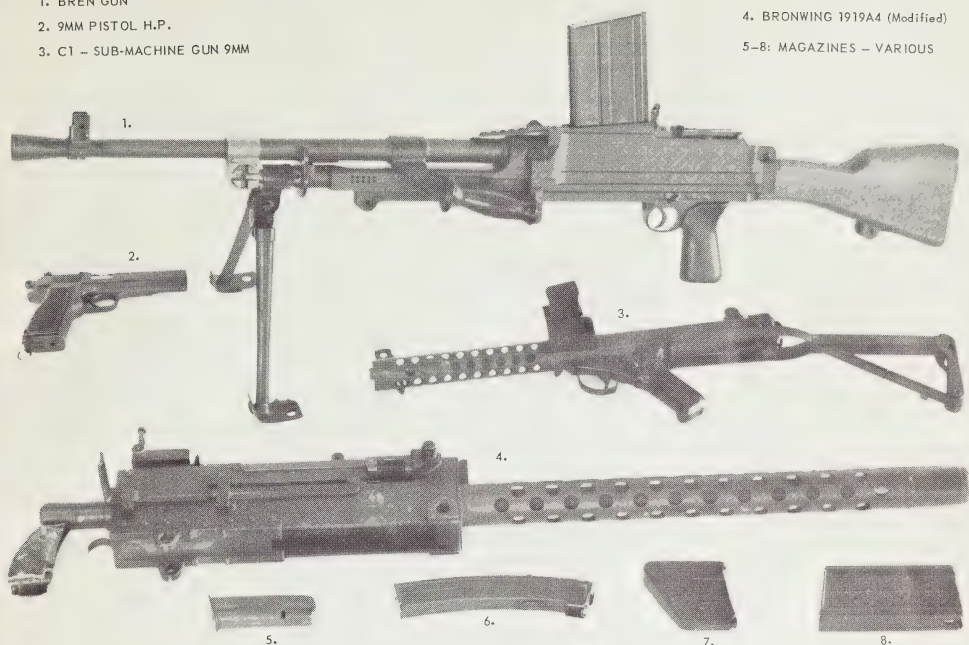
1. BREN GUN

2. 9MM PISTOL H.P.

3. C1 - SUB-MACHINE GUN 9MM

4. BRONWING 1919A4 (Modified)

5-8: MAGAZINES - VARIOUS



1. SHOT-GUN 12 GAUGE

2. # 4 RIFLE - .303 LEE ENFIELD

3. C1 RIFLE (FN) 762 MM

4. SPORTER .303

5. PISTOL BARREL

6-7: BAYONET & SCABBARD

8. REMINGTON .22 BARREL (Nylon)

9. S.A. BARREL



## **METROLOGY AND GAUGE LABORATORY:**

The Division metrology and gauge laboratory is a self contained temperature and humidity controlled relatively vibration free unit established for the control and maintenance of measuring standards used in the processing of a wide range of products both defence and commercial that can be manufactured in the Small Arms plant. The measuring equipment with some exceptions is of a universal type permitting the measuring of several features with one machine and includes a three co-ordinate measuring machine, toolmakers microscope, machines for measuring up to 80 inches (2 m), lead and pitch measuring both internal and external, internal diameter measuring to an accuracy of .00002 inches and an opposed head comparator graduated to .0000001 inches. The metrology laboratory has received R.C.A.F. approval and is listed in appendix "B" of 12 Technical Services Unit Order and Instructions T22 as a source for the complete calibration of gauge blocks as well as plain and threaded ring and plug gauges. The metrology laboratory, in addition to providing for our own internal requirements, calibrates gauge blocks and measuring standards for commercial companies.

## **DEEP HOLE DRILLING FACILITY:**

The Division possesses unique deep hole drilling capabilities and has the following machines for this purpose:—

- (1) Pratt and Whitney  $\frac{1}{2}$  B drilling machines capable of drilling holes up to  $\frac{3}{4}$ " (19 mm) diameter by 50" (127 cm) long.
- (2) Barnes drilling machines, presently drilling up to  $1\frac{3}{4}$ " (44.4 mm) diameter by 96" (2.4 m) long.
- (3) Bryant drilling machines for precision drilling of small holes to fine positional tolerances in irregularly shaped components.

Other than the drilling of all types of small arms barrels these machines have applications for the drilling of a wide range of components for industry in general. The most unusual application was the drilling of 12 coolant holes  $1\frac{1}{2}$ " (38 mm) diameter with a drilled length of 86" (218 cm) through a solid copper block weighing approximately 6500 lbs (2948 kg).

Other drilling operations include such items as the wire rope holes for catapult launching terminals, roller shafts for printing machines and thermocouple welds, etc.

Canadian Arsenals (Small Arms Division) enjoy an international reputation in design and production based on such activities as; Design Agent for the Design Authority for the 7.62 FN Rifle in use in Great Britain, Australia, New Zealand, India, Canada and other countries who have adopted it; production of ordnance gauges for the U.S. Army and more lately the Division has received commendation from the U.S. Army concerning the speed and efficiency with which M137 Telescope Mounts were produced for overseas use.









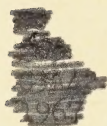






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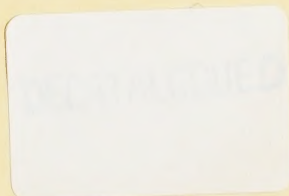
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